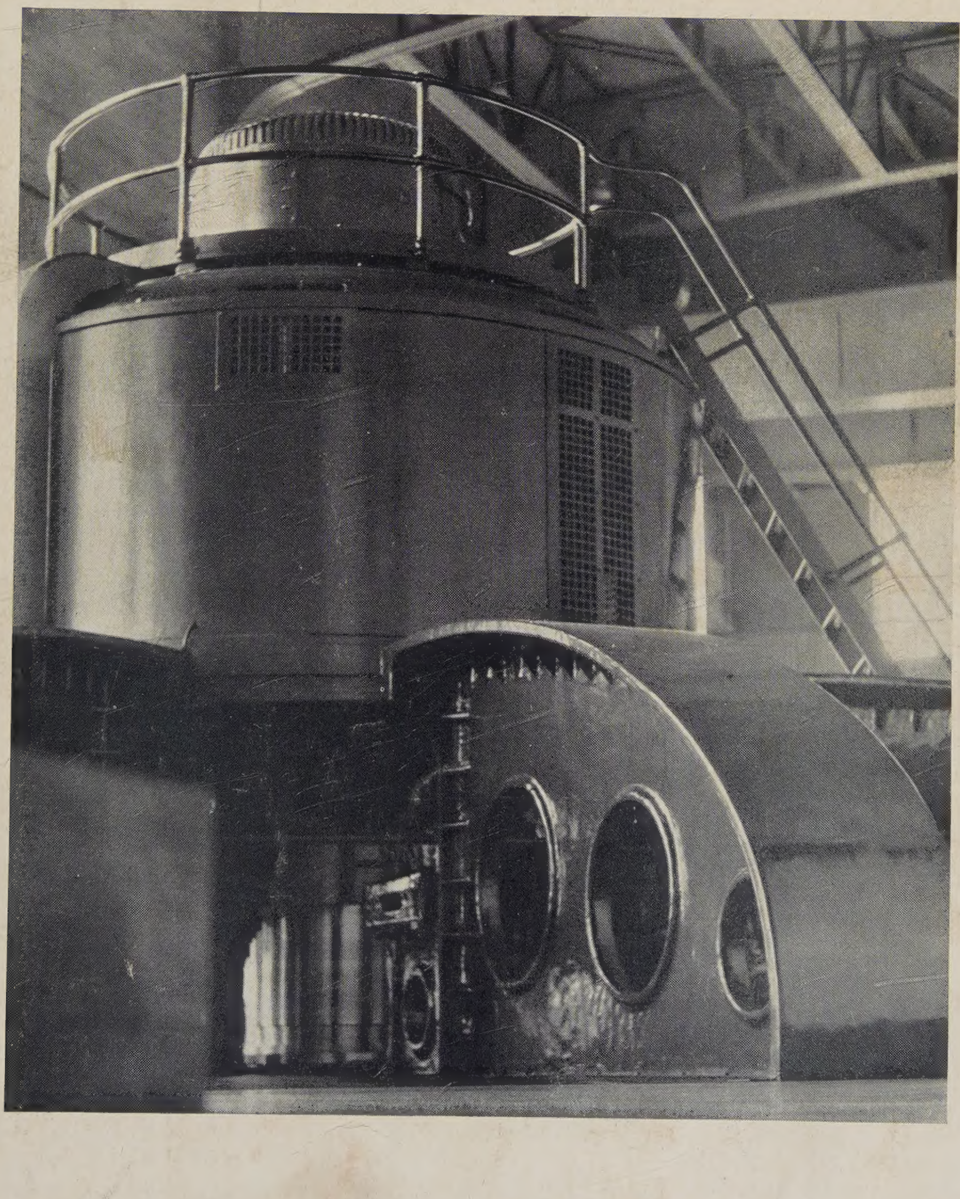
Electrical Engineering

April
1931



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FUTURE MEETINGS

of the

American Institute of Electrical Engineers

Place	*Dates*	*Nature*	*Latest Date for Receipt of Manuscripts*
Rochester, N. Y.	April 29-May 2, 1931	District Meeting	(Closed)
Asheville, N. C.	June 22-26, 1931	Summer Convention	(Closed)
Lake Tahoe, Cal.	Aug. 25-28, 1931	Pacific Coast Convention	May 25, 1931
Kansas City, Mo.	Oct. 22-24, 1931	District Meeting	July 22, 1931
New York, N. Y.	Jan. 25-29, 1932	Winter Convention	Oct. 26, 1931
Milwaukee, Wis.	March 14-16, 1932	District Meeting	Dec. 14, 1931

NOTE: Members who are contemplating submitting papers for presentation at any of the above meetings should communicate promptly with Institute headquarters, 33 West 39th Street, New York, N. Y., so that their papers may be docketed for consideration by the Meetings and Papers Committee, as programs for all meetings are formulated several months in advance. Upon receipt of this notification, Institute headquarters will mail to each prospective author information in regard to the Institute's rules relating to the preparation of manuscript and illustrations.

MEETINGS OF OTHER SOCIETIES

SEMI-ANNUAL MEETING OF THE A. S. M. E., Hotel Tutwiler, Birmingham, Ala., (Calvin W. Rice, Secretary, 29 West 39th St., New York), April 20-23, 1931.

SOUTHWESTERN GEOGRAPHIC DIVISION, N. E. L. A., Mineral Wells, Tex., (S. J. Ballinger, San Antonio Public Service Co., San Antonio, Tex.), April 21-24, 1931.

AMERICAN ELECTROCHEMICAL SOCIETY, Hotel Tutwiler, Birmingham, Ala., (C. G. Fink, Columbia University, New York), April 23-25, 1931.

NORTHWEST ELECTRIC LIGHT AND POWER ASSOCIATION, Annual Convention, Boise, Idaho, June 17-20, 1931.

PACIFIC COAST ELECTRICAL ASSOCIATION, Annual Convention, Hotel Del Monte, Del Monte, Calif., June 24-26, 1931.

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In This Issue—

Front Cover

An interesting and unusual view of one of the seven 40,000-kva. 81.8-r. p. m. generators in the Conowingo (Md.) hydroelectric plant.

—Turn to Next Page—

CORRECTION. In "Light Beams Operate Traffic Signals," by R. C. Hitchcock (March issue), the third paragraph, fifth line, page 183, should read, "lenses and resulting *in* (not *from*) the apparatus going on. . . ."

◆

DEMONSTRATING Institute activities in the advancement of electrical engineering one has only to review the subjects on the winter convention program, partial discussion for which appears on *page 299*, also papers given at the recent district meeting at Pittsburgh (*page 296*) and the tentative program for the Rochester meeting (*page 302*).

◆

SINCE the low-voltage a-c. distribution network has already proved its reliability in sections where high load densities prevail, it seems natural to think of this system being developed *vertically* to meet the load demands of very tall buildings. A. H. Kehoe, of the United Electric Light and Power Company is well qualified to give information on this subject having been in responsible charge of the development work on vertical networks since their inception. Basset Jones of Meyer, Strong & Jones, New York City a coauthor with Mr. Kehoe, has for many years been associated with building illumination and power problems. (*See page 292*)

◆

"CRACKING" low-grade oils by electricity to convert them into usable gasoline and other volatile fluids has been achieved through perseverance and super-detailed experimentation. This has been made the subject of a paper which H. R. Rowland has presented before the Institute's Kansas City Section. (*See page 288*)

◆

THE ELECTROPURE method of pasteurizing, in which an electric current is actually passed through the milk itself is the subject interestingly discussed by A. J. Dreux of the Rieck-McJunkin Dairy Company of Pittsburgh (where the process is in practical use) and H. C. Brunner, general engineer of the Westinghouse Electric & Manufacturing Company. (*See page 285*)

◆

DEVELOPING a protective relay system for long transmission lines where stability plays such a master role, is a difficult problem indeed. E. R. Stauffacher, electrical protective engineer of the Southern California Edison Company, Ltd., reviews a decade of his experiences in this work on the lines in Southern California where the situation has been further complicated by rapid and extensive system growth. (*See page 268*)

◆

OF no minor importance is the consideration of noise-frequency induction which constituted part of a symposium given at the Institute's winter convention the major features of which are abstracted in this issue. This is especially significant in view of the coordination problems involved between power and communication circuits represented respectively by H. L. Wills of the Georgia Power Company, and O. B. Blackwell of the American Tel. & Tel. Co. (*See page 279*)

Electric Communication and the New York Stock Exchange

Electric communication has grown to be an extremely important aid in the speedy transaction of business. This is especially true of the New York Stock Exchange with its hundreds of private telephone lines, thousands of high-speed tickers, and a telephone quotation bureau which handles as many calls per hour as a large central telephone office.

By Dean K. Worcester

Associate A. I. E. E.

Assistant Secretary, New York Stock Exchange

IT IS DIFFICULT to imagine a business or industry more dependent upon electric communication systems than that of a stock exchange. Perhaps the underlying reason is that no man can succeed in this business whose word is not as good as his bond; and so the telephone and the telegraph handle innumerable transactions which would otherwise require the services of the typewriter and the postman. In any event, the growth of the electrical transmission of intelligence since 1867, when the first stock ticker was placed in the New York Stock Exchange, and 1878, when the first telephone was installed there, has been rapid and continuous; and although the Exchange founded in 1792 has had the benefits of these devices for less than half of its history, one does not like to contemplate what would result today if these facilities were suddenly taken from it.

Many persons, especially communication engineers, are familiar with the great network of wires that connects Wall Street with brokerage offices, banks, investment houses, and similar institutions throughout the country. The myriad of lines, however, which enter the group of buildings comprising the Stock Exchange seem to be clothed in mystery. For this, two factors are probably mainly responsible. First, the impracticability of admitting the public onto the trading floor itself, where most of these wires have either their beginning or ending; and second, the inexorable supervision maintained by the Exchange over these vital wire connections, to prevent their improper use by gentry of uncertain antecedents and motives.

Written especially for ELECTRICAL ENGINEERING, based upon an address delivered before the Communication Group, New York Section, A. I. E. E., Jan. 6, 1931.

Business of the Exchange

The Exchange itself, be it clearly understood, does not buy or sell securities; it determines no prices, has no official quotations, and keeps no record of the transactions made upon its floor. It exists for the purposes set forth in Article I of its Constitution; namely, "to furnish exchange rooms and other facilities for the convenient transaction of their business by its members; to maintain high standards of commercial honor and integrity among its members; and to promote and inculcate just and equitable principles of trade and business."

The business which the members of the Exchange transact upon its floor is the making of contracts to purchase or sell such securities as are approved and admitted to dealing by a committee of the Exchange chosen for this purpose.

The rooms which the Exchange provides comprise at present a "board room" which, with its annex, has an area of about 22,000 sq. ft., and a "bond room" with an area of some 6,000 sq. ft. In these rooms some 1,350 stocks and 1,500 issues of bonds are dealt in. Contracts may be made only by members, (of whom there are now 1,352), and this power may not be delegated to anyone save another member. About 1,000 members are present each day upon the floor. Contracts are oral only, no written contracts nor memoranda being exchanged upon the floor. Settlement of contracts by the delivery of securities and payment of money is handled elsewhere.

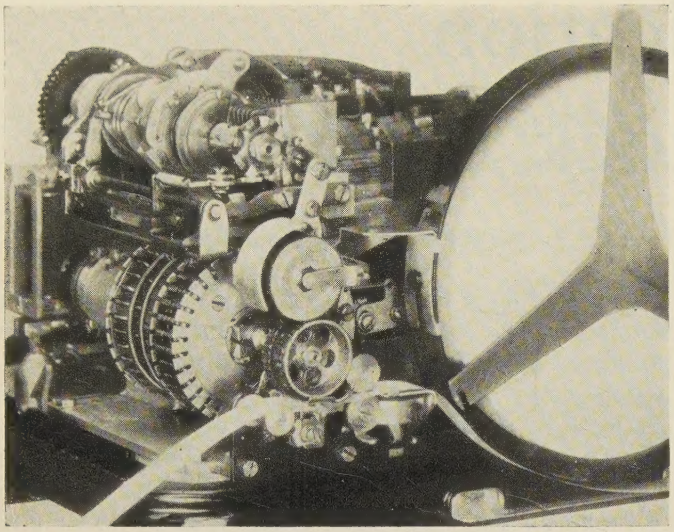
Among the facilities provided by the Exchange to aid its members in the transaction of their business upon the floor are:

1. Approximately 1,400 telephone spaces located around the edge of the trading floor where members may install private-wire connections to their offices or to the offices of other members. At these spaces members may also station their own telephone clerks who attend to the handling of orders, reports, and other business over the wires, leaving the member free to execute orders—an invaluable assistance.

2. A telephone quotation bureau, to which the bid and asked prices of stocks are continuously reported by a number of employees on the floor. Members having nearby offices may be connected by private telephone lines with this bureau, and may thus obtain within a few seconds the price bid for a stock, and the price at which it is offered, irrespective of whether or not a sale has recently taken place.

3. About 1,100 employees of the Exchange regularly stationed upon the floor carry messages, transmit written orders through pneumatic tubes (of which there are 35 miles beneath the floor), take down reports of transactions and cause them to be printed on the ticker tape, report bid and asked prices to the telephone quotation bureau, and perform other services.

4. Ticker service which is rendered by a subsidiary, the New York Quotation Company, to members of the Exchange located south of Chambers Street in Manhattan. Under a non-exclusive contract the ticker quotations are made available to the Western Union Telegraph Company, by which they are retransmitted to other members and approved non-members located in the United States, Canada, and Cuba.



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New high-speed stock ticker with cover removed

© New York Stock Exchange

Section of private-wire telephone booths. Pneumatic-tube station shown in the foreground

Note that many of the receivers are not replaced on their hooks but are simply dropped and left hanging. The receiver cords have been looped around the hooks, their weight being sufficient to pull the hooks down and thereby break the connection

The procedure by which an order to buy or sell stock is normally handled is outlined in the following.

Handling an Order

An order received in a member's office is telephoned to the floor over one of the private lines and taken down on an order slip by the member's telephone clerk. The clerk summons his broker by means of an extensive annunciator system and gives him the order. The broker then goes to the point on the floor at which trading is done in the stock in question, each stock having its own definite location. Having bought the stock, or sold it, as the case may be, he notes on the slip the name of the member or firm with whom he has traded, and the price. He then returns the slip to the telephone clerk who in turn reports the execution to his office over the private wire.

It is thus evident that the system of private wires which connects the floor with the offices of members is an indispensable link in the handling of their business. There are about 2,300 such wires, each entirely independent of the others, and it is estimated that on a moderately active day more than 2,000,000 calls are made over these wires during the five hours of trading. Obviously, a member whose communications are interrupted, delayed, or confused, even for a few minutes, would find himself for the time being practically unable to do business.

The simple private telephone line, consisting essentially of a pair of conductors having at each end a telephone instrument, a bell, and a ringing key, has proved to be admirably suited for this exacting service. It combines to a high degree the fundamental requirements of simplicity, speed, and surety.

There can be no misunderstanding as to the identity of the person on the other end of the line, for no switching takes place; the possibility of breakdown is made as remote as possible; and messages can be passed as fast as people can talk. Furthermore, any intermediary switching device would make it less difficult for unauthorized and unscrupulous persons to get into communication with the Exchange floor; and so it is a rigid requirement of the Exchange that all lines shall be private, and shall terminate at each end either in a separate instrument, or in a simple key-set, turret, or monitor, which, if used, shall be restricted exclusively to the use of such lines. The lines themselves are installed by the New York Telephone Company under a contract with the Exchange, and may be connected, moved, or disconnected, only by an order from the Exchange.

High-Speed Ticker System

A wholly different communication problem is presented by the ticker system.

The present ticker instrument is simply a high-speed printing telegraph, controlled over a single-wire circuit, and driven from a local power source, usually the subscriber's lighting system. The New York Quotation Company owns and operates approximately 2,500 tickers, together with underground conductors, transmitting apparatus, and other equipment, all located as described, in southern Manhattan. This company has exclusive access to the Exchange floor for obtaining reports of transactions. The Western Union Telegraph Company obtains quotations from a New York Quotation Company ticker; re-transmission is effected by

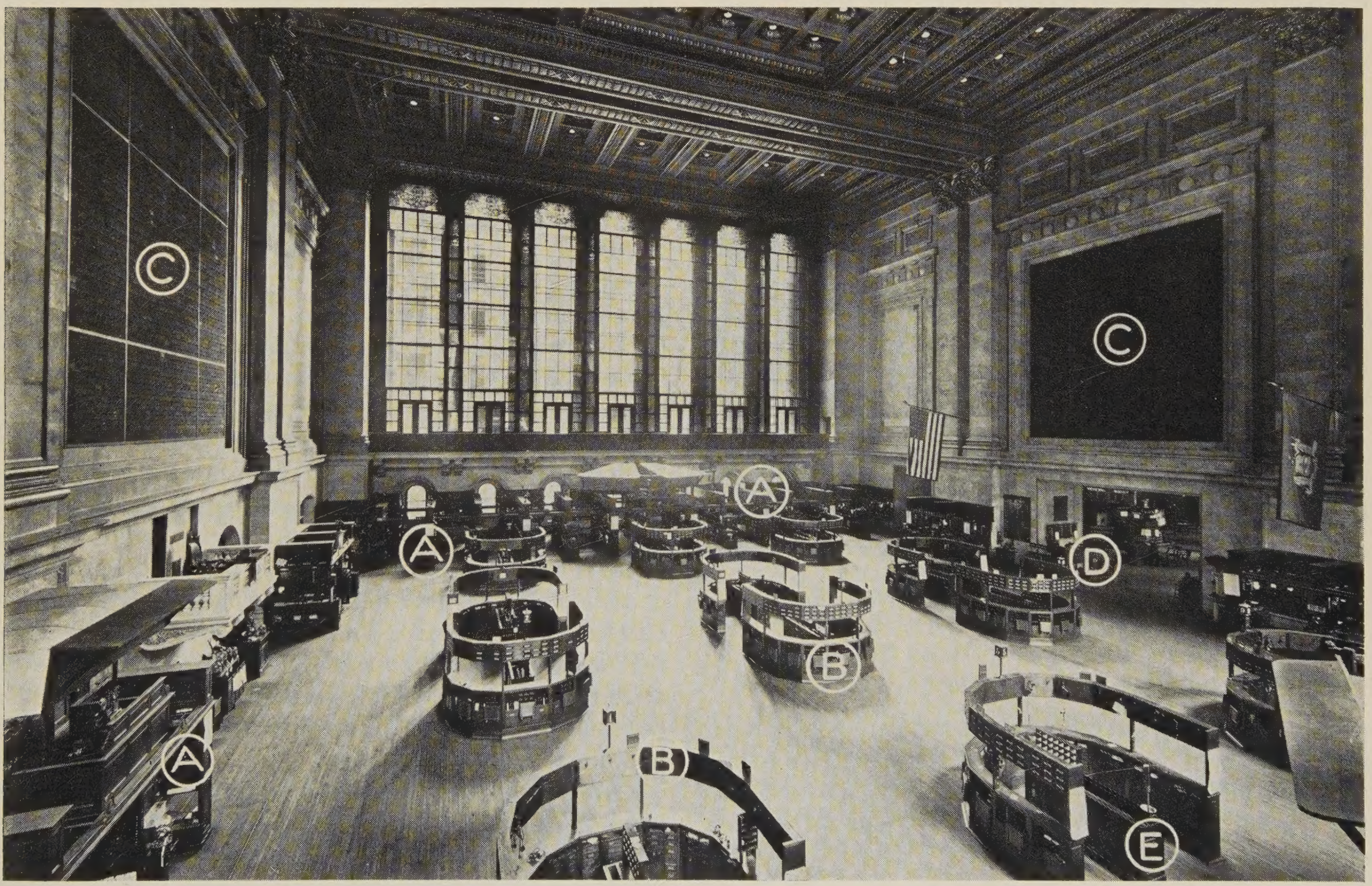
that company by means of an ingenious double-manual keyboard which without disturbing the sequence of quotations enables two operators to cooperate in copying them from the tape, the operating speed of 500 characters per minute being far too great for one person to handle.

Among the 1,100 Exchange employees stationed on the floor are more than 200 reporters who make note of each transaction as it occurs, writing on a slip of paper the name of the security, (abbreviated, of course), the amount sold, and the price. These slips are dispatched without delay to a transmitting operator, who sits at a perforator keyboard and perforates a paper tape with the code corresponding to the characters which are to be printed. There are six such transmitting stations, which were formerly located at separate points on the floor. Recently these have been brought together on an elevated platform, to which point the report slips are sent through pneumatic tubes.

The six perforated tapes are summarized by a reperforator on a master tape which passes through a master transmitter and operates the ticker system. At each of the six stations just mentioned a ticker is provided, and in order to detect any errors which may have crept in, the report slips after being transcribed by the keyboard operator are immediately and carefully compared with the printed tape.

The Exchange uses every effort to make the ticker tape an accurate and punctual record of what takes place on the floor; but in spite of safeguards and notwithstanding the high level of mechanical and electrical precision at which the ticker system is maintained, errors must sometimes occur. Consequently, the tape cannot be, and is not, looked upon as an official record but merely as the best record that it is possible to keep.

It is regrettable that the historic days of 1929, with the resulting market activity which continued into the early summer of 1930, did not hold themselves in abeyance a few months more; for on September 2, 1930, the new high-speed ticker system operated as such for the first time, but since that date has had little opportunity to test its capacity in a really active market. The old ticker system printing 275 characters per min. found difficulty in keeping abreast of a four-million-share day,



General view of trading floor of the New York Stock Exchange showing (A) private-wire telephone booths; (B) trading posts; (C) annunciator call-boards for brokers; (D) money desk; (E) pneumatic-tube stations connecting trading posts with telephone booths

and on eight- or ten-million-share days the tape was sometimes hours behind the market.

The new ticker prints 500 characters per minute or slightly less than twice as many as the old machine. Yet its adequacy in terms of shares of stock is believed to be far greater than this two-to-one ratio. Records show that as the volume of trading increases, the number of tape impressions per hundred shares of stock sold falls off sharply, thus enabling a given number of impressions (such as the number that can be printed during one hour) to record a far larger amount of stock. For example, on a four-million-share day the average number of impressions per hundred shares is about 2.0; at eight million shares per day this figure is more nearly 1.4; and at twelve million shares, the data though they are few indicate that the coefficient is about 1.1. The reasons for this are twofold; first, the Exchange itself takes steps to abbreviate the record on the tape by omitting volume figures or by printing only the last digit and fraction of the price instead of the full price; and second, the average number of shares of stock per transaction becomes larger, yet it takes only a little more work for the ticker to record a sale of 5,000 shares than a sale of 200 shares.

In any event, the new ticker can print 150,000 characters during the five hours of trading; if the number of required impressions per hundred shares is 2.0, the ticker can thus record 7,500,000 shares; but at 1.1 impressions per hundred shares, the ticker could keep effective pace with a turnover of about 13,500,000 shares per day. Of course trading does not run at a uniform rate even for a single day; but it seems safe to expect that the ability of the new ticker to keep pace with the market will prove much greater than its printing speed alone would indicate.

General view of telephone quotation bureau before installation of bulletin boards

Telephone Quotation Bureau

The telephone quotation bureau makes available to members' offices on short notice the latest bid and asked prices of any stock they may desire. By bid and asked prices are meant the prices at which stock can be sold (bid) or purchased (asked)—information which is obviously of considerable value to a person who contemplates placing an order to buy or sell. Prior to the early part of 1929 this could be done only by telephoning the floor via one of the private wires. A broker or page would then be sent to the place on the floor where the stock in question was being traded (often a hundred feet or more away) and in due course the quotation would be reported back over the telephone. This resulted in delay and caused serious traffic congestion upon the floor. To cure this situation, the telephone quotation bureau was established. It consists essentially of a distributing switchboard to which the offices of subscribing members are connected by private wire; a number of groups of "quotation operators" seated at tables connected by trunk groups to the distributing board; and a bulletin board for each group of operators, upon which the current bid and asked prices of a number of stocks are posted.

On the Exchange floor are over 100 "quotation boys," each of whom covers one or more stocks; any change in the bid or offer is reported to the bureau by direct telephone line, and the prices shown on the bulletin are changed to correspond. A member desiring a quotation dials a two-digit code (as the distributing board is now machine-switching) which he obtains from a printed booklet containing the names and codes of all listed stocks. A trunk is thus selected which connects the member to the group of operators before whom are posted quotations for the stock in question; he states the name of the stock wanted and receives the quotation.

Many vicissitudes were experienced during the development of this system. No basic engineering data were available. It was known only that the number of daily requests for quotations as determined by actual count upon the Exchange floor amounted to about 8,000 calls per day. Nothing was known as to how this volume might increase upon the introduction of a fast telephone service; holding times, operator's loads, and trunking requirements, could only be guessed at. A safety factor of 300 per cent was finally chosen, and the first bureau was accordingly opened early in 1929 with an estimated capacity of 24,000 calls per day. Suffice it to say that within a few months an entirely new bureau was ordered and before it could be built and placed in service the old bureau was handling 54,000 calls per day.

This new bureau opened last July is expected to take care of 20,000 calls per hour, or 100,000 per day. Incidentally, although this bureau has only about 350 incoming subscribers' lines, this hourly rate of 20,000 calls is greater than that of most major central telephone offices having as many as 10,000 lines each.

Although the new bureau like the new ticker has had little chance to give an account of itself, yet over 9,900 calls have occasionally been handled during 30 minutes.

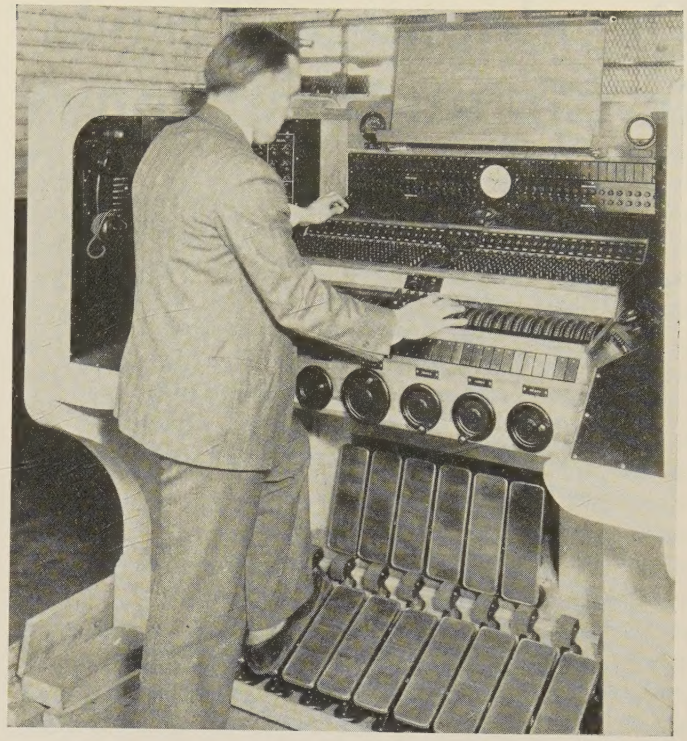
Some interesting engineering features of the quotation bureau arise from the large number of stocks quoted (about 1,000 active and 350 inactive); the very high calling rate (over 50 calls per line per hour); the extremely short holding time (about seventeen seconds average, of which from six to eight seconds are consumed in dialing alone); and the continually changing concentration of traffic. Within half an hour some stocks are called for hundreds of times; others only once or twice a month. Some stocks which have lain dormant for months may suddenly flare up and as suddenly die, while new stocks may be added on only a few hours' notice. The equipment on the Exchange floor where the all-important information is gathered must be susceptible of uninterrupted rapid use by over 100 people without interfering with the activities of some 3,500 other people who on a busy day are very busy indeed.

Since the introduction of the telephone and electrical ticker into the New York Stock Exchange more than 50 years ago, electric communication systems have grown to be an almost indispensable link in the transaction of its business. As has been shown, the equipment making up these systems must meet the exacting requirements of fast, continuous, and dependable operation, since a failure or delay in any part would result in impeding if not completely interrupting the activities of some of the members. With the growth of the Exchange these systems have grown steadily and undoubtedly will continue to improve and expand according to the dictates of a constantly increasing volume of business.

Color Console For Theater Lighting

BY MEANS of vacuum tubes, a "light artist" at the "color console" of Cleveland's Severance Memorial Hall has hue and intensity of auditorium and stage lighting at his finger and toe tips, just as a pipe organist finds pitch and volume of sound at his command.

This unique Westinghouse lighting switchboard, built into an ordinary organ console, has the ability to "remember;" four complete scenes may be set up in advance to be called forth at will by throwing a master switch. The different scenes can form a continuous program, one scene automatically merging into the other at controlled rates. The vacuum-tube control scheme is the means of reaching for the first time the long sought goal of "proportional dimming"—that is, previously-set intensities of various groups of lamps keep their same relative brilliance while being dimmed. However, the operator at his console has every lighting effect subject to his will at all times.



Front of color console showing arrangement of controls

Hitherto, theater-lighting switchboards have lurked in the wings, because they were too ugly and cumbersome to be placed in more desirable locations; a new means of governing the grids of vacuum tubes enabled engineers to concentrate the "nerve centers" of nearly 4,000 lighting combinations in an ordinary organ console. Such a console is portable, a 40-ft. extension cord allowing it to remain on the stage or ride the elevator platform in the orchestra pit.

This "light console" has 36 main-control drums which project ¾ in. above the face of its keyboard panel and are spaced only 15/16 in. apart. These 36 controls brighten or dim a total of 110 lighting circuits.

If the operator needs his hands for other work, or if his fingers tire, a slip of a switch transfers the intensity control to a group of nine horizontal foot-pedals. Four slanting foot pedals can be made master controls for groups of circuits. For instance, by manipulating two of these master pedals half the lights could be dimmed simultaneously while the other half increased in brilliance.

On the diagonal sides of the console are 110-cross-connecting switches for distributing the various circuits among the 36 control panels. Relays in the basement apparatus room do the actual work of connecting the proper vacuum-tube units to their associated apparatus and lamps.

Development Trends in Circuit Interrupters

Several novel circuit interrupting devices are showing possibilities of commercial importance, some representing improvements to oil circuit breakers and others indicating a possible trend toward the non-oil type of equipment. Deion, compressed-gas, expansion, vacuum, and oil breakers are discussed briefly in the light of present laboratory knowledge.

By J. B. MacNeill
Associate A. I. E. E.

Manager, Circuit Breaker Engineering Department
Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

SEVERAL of the many novel ideas for the interruption of high-powered, a-c. short circuits that have been advanced during the last two or three years present attractive features as compared with conventional equipment. Only tests and field service over a period of time can determine the proper place in the electric power industry for each development, since the various ideas presented are too dissimilar to enable the casual observer to form an opinion of relative merits.

At the same time there is a feeling among both the manufacturers and users of high-power circuit breakers that the industry is already too much burdened with complication due to voltage ratings, carrying-capacity ratings, structural arrangements, and many other features more or less special with groups of operating people. It may be conceded that the introduction of radically new forms of circuit-interrupting devices will not automatically simplify present day complication, but unless carefully supervised may only complicate the situation still further.

Generally this problem of circuit-interrupting apparatus is subdivided in two ways: first, into indoor and outdoor apparatus; and second, into low-voltage and high-voltage apparatus. In America, practically all switching equipment above 25 kv. is outdoor, so that a view of the situation is simplified by thinking of the problem in two parts; the first, indoor apparatus at 25 kv. and below, and the second, all outdoor apparatus. The merits of a proposed device to meet the requirements of these two classifications is important in connection with newer ideas.

From "The Trend in Development of Modern Circuit Interrupters," (**No. 31-3**), presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1931.

Deion Circuit Breakers

It is only in the past few years that the cold-cathode arc has been studied, and the theory of current being carried to the cathode by positive ions diffused from a highly thermally-ionized gas layer adjacent to the cathode has been advanced in support of it.[1–4] This conception of a cold-cathode arc has been followed by considerable advance in the rupture of high-voltage circuits in air. Further research investigation[5] disclosed that after a current zero the thin layer of gas immediately adjacent to the cathode regains a rather definite dielectric strength at a rate faster than voltage restored across any practical operating circuit.

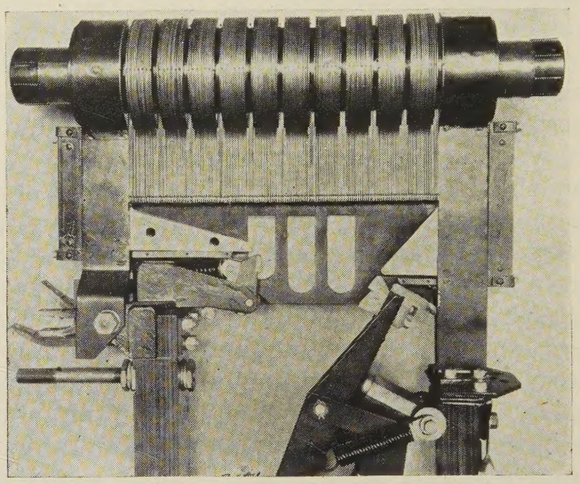


Fig. 1. Partial assembly of a 600-ampere 15-kv. deion air-break circuit breaker designed for 500,000 arc kva.

These ideas of the cold-cathode arc and the relatively high dielectric of the cathode gas layer may be considered in some respects to form the fundamental nucleus of the deion breaker.[6]

Considerable progress has been made in the past year in the development of commercial apparatus involving the deion idea. This work has been based upon laboratory tests[7], and further check by an extensive series of field tests up to 550,000 arc kva. at 12 kv.[8], and other field tests up to 800,000 arc kva. at 24 kv.

A limited number of breakers rated 500,000 arc kva. at 15 kv. has been in 12-kv. service for more than a year without difficulty. A considerable number, approximately 160 pole units, of the same rating has been placed in service during 1930 on from 11 to 13 kv. There are at present under way numerous tests on a breaker for 1,000,000 arc kva. at 15 kv. The plate unit of this breaker is shown in Fig. 2. An improved breaker designed for 1,500,000 arc kva. at 25 kv. has been built and is shown in Fig. 3. Work is well under way on a breaker for 250,000 arc kva. at 5 kv.

1. For references see bibliography.

By referring to Fig. 2 it is seen that a considerable modification has been made in the plate structure as compared to the older "key" form of plate shown in Fig. 1. In the newer construction each plate is provided with a vent direct from its own arcing space. This vent is much more direct than the older method of venting at the end of the arc-drawing space shown in Fig. 1, and therefore superior heat elimination after short circuit is secured. This in turn increases the rupturing capacity of a given sized plate and the number of operating cycles to which it may be subjected.

The new plate structure eliminates the large blow-in coils previously necessary on the sides of the chamber, thus making arc transfer into the plates easier by reducing complication and eliminating the possibility of voltage puncturing from the coils and magnetic circuits to the opposite polarity inside the chamber. This new design of plate has made possible the building of 25-kv. breakers in a single unit and in a space fairly comparable with 15-kv. designs.

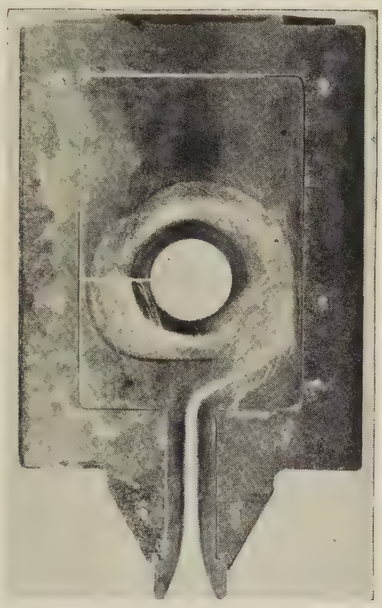


Fig. 2. A deionizing plate from a 1,000,000-kva. deion air-break unit

So far as can be seen there is no immediate limitation to the rupturing capacity of deion air breakers. Like other non-immersed switching devices, however, they are subject to the limitations of present day insulating materials. While development along this line is possible, it seems advisable for the present to limit this type of circuit breaker to 25-kv. service and below, and for the most part to indoor applications. An insulation test of 80 to 100 kv. with a breaker open or closed can be secured with reasonable construction for 25-kv. service. If atmospheric conditions are normally good, this appears sufficient giving a relatively small deposit of dirt and moisture.

Compressed Gas Circuit Breaker

The idea of using compressed gas for interrupting high-voltage circuits is not new and has been worked on by several concerns. However, with the aid of adequate test facilities, the A. E. G. of Germany has sponsored this development and much progress has been made. Several technical papers by the inventors and designers of this equipment have been presented to the industry.[9] Fig. 4 shows the design of this breaker for 10-kv. service. The high-voltage circuit is made at the top of the tube through a terminal which is connected by the moving contact to the lower terminal at the bottom end of the tube. Operation is generally secured by an air cylinder fed from the same source of air pressure which gives arc rupture, and the mechanical operation of the device is so arranged that movement of contact parts and valve actions assure air pressure simultaneously with, or just previous to, the parting of contacts. There is thus no possibility of drawing a high-voltage arc without necessary pressure for rupture being present. For the purpose of assuring several repeated operations without the necessity of air from the main storage, the pressure in the air reservoir at the breaker is generally quite high. It is reported that in a typical case, an air pressure of 15 atmospheres (225 lb.) is reduced to 11 atmospheres after the first short circuit, 7 atmospheres after the second short circuit, and approximately 4 atmospheres after the third short circuit. An initial pressure of approximately 7 atmospheres is adequate, therefore, provided the pressure can be renewed after each short circuit.

The compressed-gas breaker has the advantage of an adequate supply of arc-extinguishing gas immediately available when the arc is started. It is extremely clean in operation with no liquids to be spilled and no large deposits, such as carbon, to be cleaned from contact parts. Furthermore, it seems to operate with low arc energy, and due to the use of special contact materials the depreciation of these parts is small.

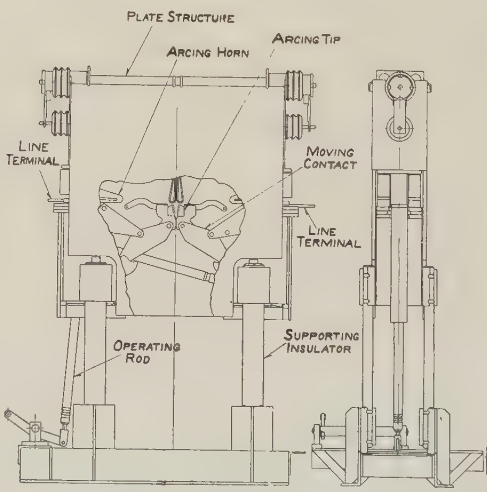


Fig. 3. Outline of single-pole unit for 1,500,000-kva. (arc) 25-kv. deion air-break circuit breaker

This device has the disadvantage of requiring at all times clean, dry air under pressure ready for instant use even though under service conditions the breaker may not operate for days or perhaps weeks. The use of air in train control where apparatus is inspected frequently and operated many times daily has reached a stage of high efficiency in this country, but the use of air valves where their operation is only infrequent has not been altogether favorable. The use of porcelain insulators subjected to sudden blasts of gas pressure may present some difficulty, and the possibility of moisture in the air affecting insulation value has to be reckoned with. The insulating limitations are similar to those of other non-immersed devices, and applications on indoor and relatively low-voltage lines present less hazard than do those for outdoor or higher voltages.

On the whole, the development of this device is a noteworthy engineering achievement and it will doubtless assume some commercial importance in the voltage classes for which it is best suited.

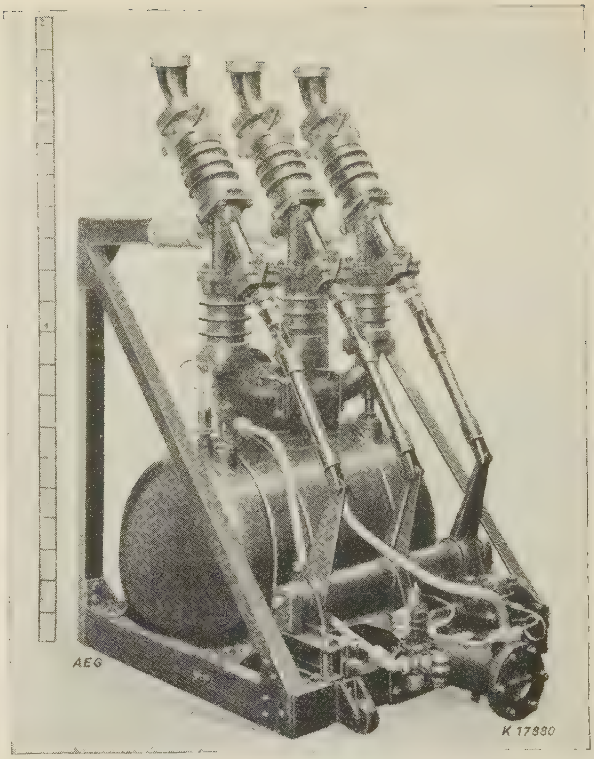


Fig. 4. Three-pole, pneumatically-operated, 600-ampere, 10-kv. breaker

Expansion Breaker

The development of a live-pot circuit interrupter using water is being sponsored by the Siemens-Schuckertwerke of Germany.[10] A breaker for 10-kv. service is shown in Fig. 5. A considerable number of these breakers is being manufactured for 6- and 10-kv. service, and some with ratings up to 500,000 arc kva. have been placed in successful operation in Germany during the past year.

The principle of arc interruption underlying the device is expressed in the following formula:

$$-\frac{dT}{dt} - K\frac{dV}{dt} > 0$$

Here T is the absolute temperature of the vapor in the arcing space, V is the instantaneous value of the restored voltage, and K is a value constant for a given fluid and pressure but varying with these factors. This formula states that the rate of temperature decrease must be greater than the value obtained from a constant multiplied by the rate at which voltage appears across the contacts after the current has become zero. In accordance with one possible theory offered in explanation of arc extinction, this decrease in temperature is accompanied by a corresponding condensation of moisture on the electrons, thereby increasing their inertia and making impossible a breakdown of the space between the contacts.

Fig. 5 shows a breaker of three pole units, each having a chamber mounted on a porcelain column. Above each chamber there is a triangular, hooded structure containing an operating mechanism mounted upon another column of insulating material. This unit is of the single-break-per-pole type and the moving contact operated by the rod in the rear is shown protruding from the operating mechanism chamber.

The fluid chamber is divided into two parts, the inner chamber being filled with water or other liquid, and the outer chamber being a water storage space and air space to allow rapid expansion of the gas when it passes through the throat bushing of the inner chamber. Vent pipes from the outer chamber are provided for leading the expanded, moist gases safely away from the vicinity of the arc-rupturing space.

Arc interruption is secured by adiabatic expansion of the gases through the throat bushing into the outer chamber. This action causes the temperature decrease and corresponding moisture condensation in the arc stream, which in turn reduce movement of the electrons and increase the dielectric strength of the arc path.

In 1921 L. C. Nicholson developed a device similar to the expansion breaker which successfully interrupted short circuits up to 6,000 amperes at 66 kv. on a single-pole unit on the lines of the Niagara Lockport & Ontario system. Mr. Nicholson's device differed radically, however, from the expansion breaker, in that it depended upon extremely high speeds of mechanical movement for proper circuit rupture.

The engineering development of this expansion breaker has been very ingenious and many of the difficulties confronting it at the beginning have been removed. The use of water instead of oil seems to be feasible—at least for low voltages—and evaporation is not excessive. For low operating temperatures, the mixture of some compound such as glycerine with the water is necessary and apparently permissible. The

question of contacts for large current capacities necessarily complicates the design but the difficulties are not insurmountable.

Since the rate of gas expansion depends upon the throat area, the design of the throat parts requires much work in order that proper deionizing action will occur over the whole range of currents and with different circuit voltage conditions. In the past, difficulty of this nature has been encountered with devices having similar characteristics; the designers feel that these problems have been successfully solved. The possibilities of explosive gas formations caused by breakdown of water into hydrogen and oxygen have been investigated and no dangerous conditions found. Naturally a device of this kind possessing the general insulation limitations of non-immersed apparatus is more suitable for lower voltages and for use indoors than for outdoors. An interesting feature of the design is the air-gap between the expansion chamber and moving contact when the breaker is open; in some cases the designers feel this may obviate the necessity of disconnecting switches, although of course it would be unwise to work on the breaker structure without such safety provision.

Vacuum Breakers

In general, the present indications are that while a properly constructed vacuum circuit interrupter would give a high grade of rupturing performance when interrupting low-current circuits, and may handle high voltages with very small contact separation, a material advance in vacuum technique will be necessary before this device can be developed to the point of dependable operation on high-power circuits, such as are encountered in present day switching service. At the moment, in spite of the large amount of intelligent development work done on the idea, the vacuum circuit breaker has no commercial importance.

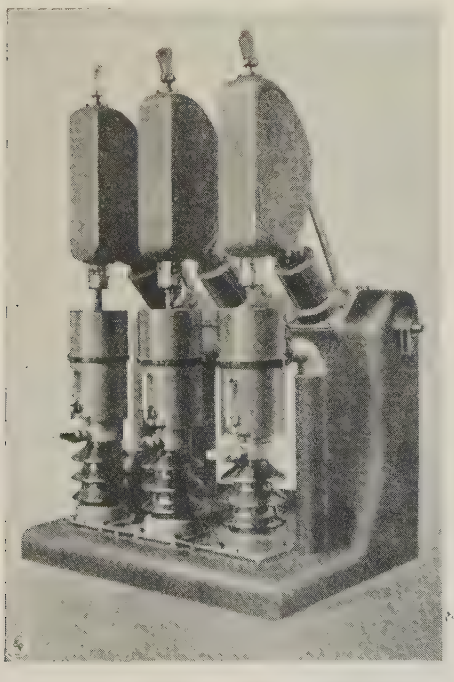


Fig. 5. Three-pole, electrically-operated, 600-ampere, 10-kv., 400,000-kva. (arc) expansion breaker

General Comments on Oil-Less Breakers

In studying the work that has been done on breakers not using oil, one is forcibly impressed with the great ingenuity that has been necessary to overcome the troubles encountered. Insulation and voltage distribution quite low in the voltage range sometimes become serious questions. At times the ability of an oil insulating medium to erase broken-down arc trails, to absorb large amounts of energy by volatilization of a small amount of liquid, and to close in and cool off immediately all necessary parts, is sadly missed.

Modern non-oil devices as a whole are characterized by reduced arc energy, increased speed of switch operation, and improved contact materials. These all tend toward quieter and more satisfactory performance under short circuit, and reduced maintenance. Highly scientific work has been possible with modern facilities for test and demonstration of theories. Undoubtedly much more is known of principles of arc rupture as a result of this work.

Oil Breaker Development

It is only natural that high-power testing equipment now available to several large manufacturers should influence the design of oil breakers as well as that of oil-less breakers. Much improvement has been made along the lines of reduced arc energy, reduced arcing time, and a lower over-all switching time. Field tests have shown complete circuit-breaker operation of from six to eight cycles for 220-kv. systems, and from five to six cycles for lower-voltage systems, from the instant relay contacts are closed until the short circuit is extinguished. This performance is accompanied by arc energy constituting a fraction of that resulting with older breakers, with consequently reduced maintenance as well as assurance of adequate rupturing ability.

Advances in design continue to be reported by manufacturers of oil circuit breakers using widely different interrupting devices including multiple breaks, high-speed contacts, explosion chambers, and deion grids, and in some cases special arrangements of magnetic blowout. The limitations of all these devices have not been reached, but given similar performance in the way of high-speed action, reduced arc energy, and physical demonstration due to gas pressure, there is an inclination to favor the simpler devices as requiring less maintenance.

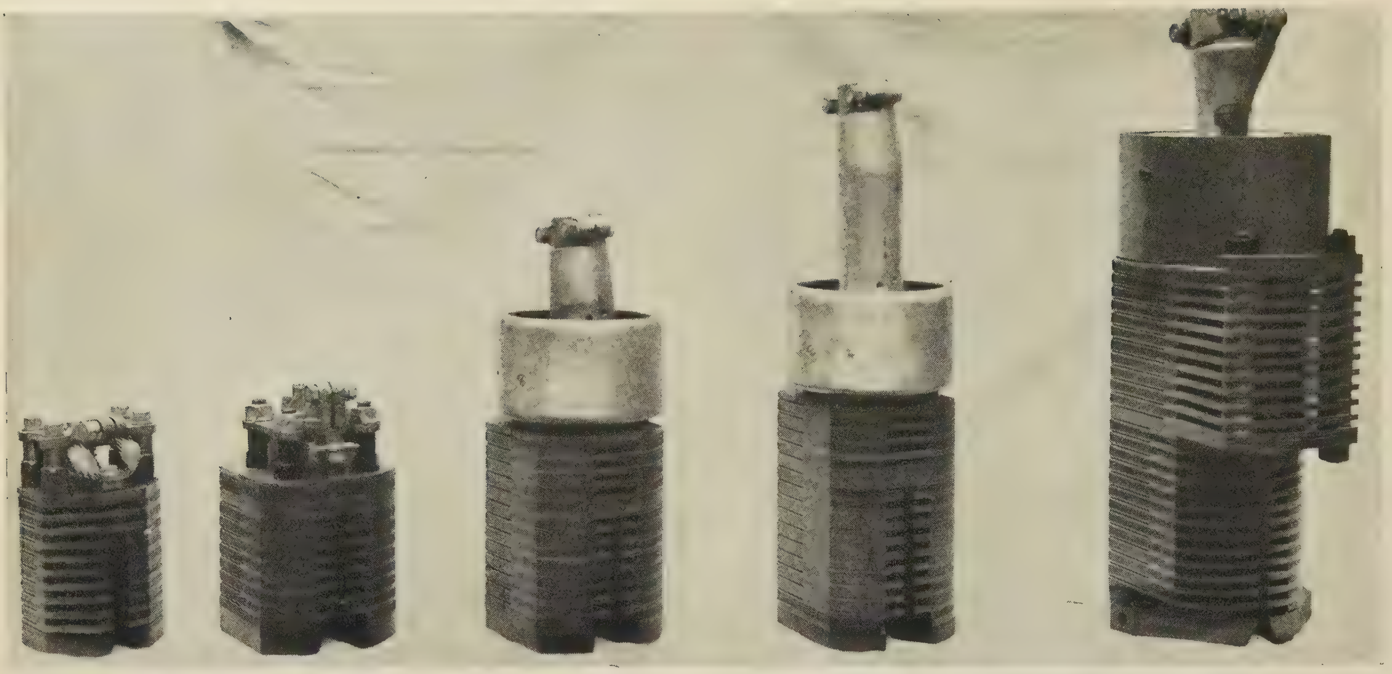


Fig. 6. Deion grid assemblies (from left to right) for installation in 34.5-46-kv., 69-92-kv., 115-kv., 138-kv., and 230-kv. oil circuit breakers

Deion Grids

A year ago this device was new and its preliminary development was reported.[13,14] At that time, practically no operating experience was available and results of certain important field tests were just being received. A broad commercial development of this idea has occurred in the past year and the deion grid may now be obtained as standard equipment for breakers of all voltages above 25 kv. and for interrupting capacities up to 2,500,000 arc kva.

The effect of powerful magnetic fields on the arc in oil breakers had been known for some time[1] and commercial apparatus for high-speed operation giving ½ cycle of arcing over a wide range of current from 2,000 amperes upwards at 12 kv. has been placed in service. Analysis of these results in the light of recent fundamental arc research showed that powerful deionizing action was at work. The blowout action of the magnetic field by extending the arc rapidly outward was maintaining it in intimate contact with fresh oil, and the gas generated by this contact between oil and the intense heat of the arc was unusually effective. This continual introduction of fresh un-ionized gas into the arc stream resulted in a high rate of deionization not possible by diffusion of ions into gases playing around the periphery of the arc. The arc path naturally regained sufficient dielectric strength to withstand restored voltage in a short time. This idea held hope of improvement in high-voltage breakers provided a proper physical application of the idea could be made. Ordinary blowout devices consisting of large coils and pole faces are not adapted for extremely high-voltage work, as the attendant problem of proper insulation is practically insoluble.

The use of oil in high-voltage breakers, however, presents a great advantage; the necessity for moving the arc terminals considerable distances from the original arc-drawing surfaces to scavenge the area between contacts did not exist. It was necessary only to develop means for utilizing the natural mobility of the arc and the inherent immobility of the oil while maintaining intimate contact between them, and to provide that the gas generated should pass effectively through the arc stream for deionizing purposes. This advantage was found in the deion grid, which provides a magnetic field to move the arc along a confined path as well as means for solidly entrapping the oil in this path with proper provision for gas escapement through the arc. Fig. 6 shows a number of these grids of various sizes suitable for a wide variety of operating voltages.

The introduction of the deion grid has been accompanied with intensive laboratory and field testing work, so that its performance has been carefully measured and its fundamental principles thoroughly understood. There is, therefore, assurance of satisfactory operation not procurable in the past, with novel devices for circuit interruption.

Performance of all sizes of deion grid is fairly comparable. For average circuits, 10 kv. can be opened per inch of break distance on a single break per pole and 20 kv. per inch of lift-rod movement on the conventional breaker having two breaks per pole. In

the average case, arc energy is reduced to approximately 7 to 10 per cent of that obtained with usual open-break devices.

Conclusions

An analysis of circuit rupturing ideas now before the industry justifies the following conclusions:

1. Several ingenious and rather well-developed devices which do not use oil as a rupturing medium are fast becoming available for commercial use.

2. All these devices, while possessing good arc-rupturing characteristics, are subject to the limitations of available insulating materials. Their application to high-voltage systems makes difficult the problem of coordinating the impulse values of lines and apparatus.

3. For reasons of insulation and difficulty of operation in unfavorable locations, conservative engineering would seem to limit the use of these non-oil-filled breakers to voltages of 25 kv. and below, and for the most part to indoor service.

4. Other things being equal, preference will naturally be extended to that form of non-oil circuit interrupter requiring no arc-rupturing medium, whether such medium be compressed gas, liquid, or vacuum.

5. Improvements have been made in oil circuit breaker design which assist system stability, reduce arc energy, and contact wear and breaker maintenance.

6. To secure coordination of apparatus and line insulation on large systems, the growing requirements for ample insulation factors on high-voltage circuit breakers, after, as well as before, rupturing duty has been performed, makes the use of oil in circuit interrupters extremely desirable for ratings above 25 kv., especially in outdoor service.

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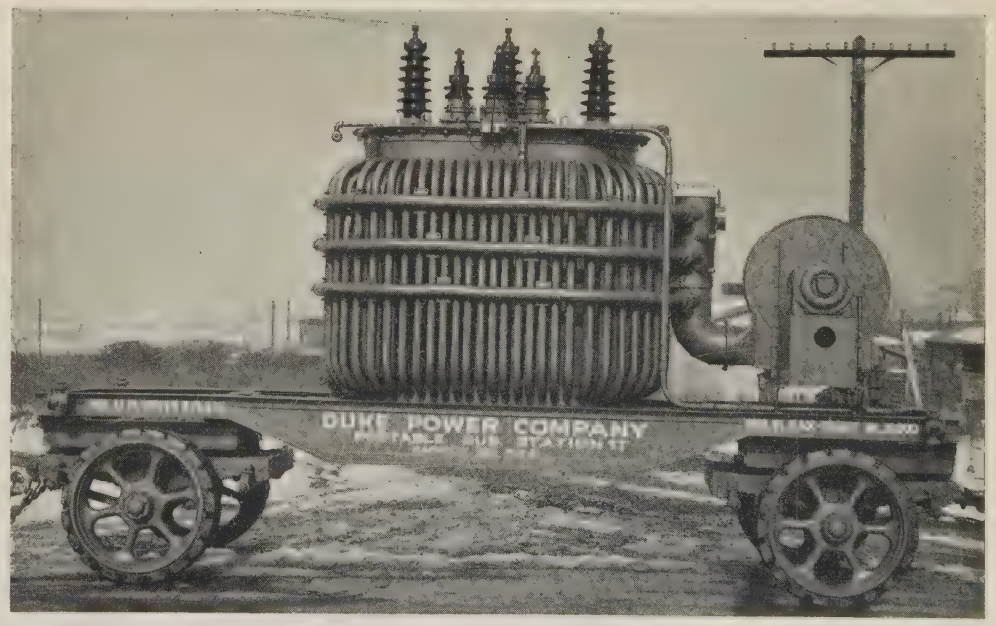
Portable Substation for Emergency Industrial Use

As an outgrowth of its railway-car portable substations the Duke Power Company, Charlotte, N. C., is using four of these 1,320-kva., 44-10/2.4 & 0.6-kv. trailer-mounted portables to back up the service of its 225 industrial substations. Total service weight is 21,400 lb., 1,400 lb. more than the legal highway limit, necessitating the withdrawal of five drums of oil before moving the equipment over a state highway—a condition, however, which expedites a necessary inspection of the terminal board and provides a load for the pulling truck thereby increasing its traction. The trailer may be handled from either end.



Current Collection in Hydrogen Atmosphere

Test runs of commutators and slip-rings operating in hydrogen gas reveal interesting characteristics and lead to five definite conclusions.

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THE FIRST electrical machine to be operated in hydrogen was the synchronous condenser, chosen largely because of the ease with which it could be covered by a gas-tight housing. Probably the next advance will be the application of a direct-connected exciter to one of these machines and that will require the exciter to be operated in hydrogen. If it is proved that commutation can be accomplished satisfactorily in hydrogen it may not be long before the hydrogen-cooled synchronous converter will make its appearance; therefore it would seem that much depends upon the accumulation of knowledge on the general subject of commutation and current collection in hydrogen. It represents a field which until just recently had received no attention. Whether or not there will arise any new and serious difficulties remains yet to be seen.

This paper is not intended as a complete treatise of the subject but only as a beginning. It describes a few tests made on commutator machines and slip-rings running in hydrogen which although not extensive establish a few facts quite conclusively.

Commutation Tests

Upon starting each new test it was necessary to pass considerable hydrogen through the tank to wash out the air, but after a good hydrogen purity was once established it was sufficient merely to maintain a small positive pressure in the tank.

Table I gives the results of five brush-life tests made on a short-circuited generator. All tests were made with full-load current in the brushes, but the generator was not always adjusted for the same grade of commutation. Tests Nos. 1, 2, 3 and 4 were made with 30 per cent of the current shunted from the commutating-pole winding of the generator. The sparking at the trailing edge of the brushes was quite severe and even under the most favorable conditions naturally resulted in rather short brush life. Test No. 5 was made with almost sparkless commutation.

TABLE I—CALCULATED BRUSH LIFE OF GENERATOR BRUSHES

Test No.	Duration of test—days	Atmosphere	Calculated brush life in days: Brush No. 1	Brush No. 2	Brush No. 3	Brush No. 4
1	15.0	Air	588.0	229.0	812.0	362.0
2	6.41	Hydrogen	94.4	9:2	128.0	10.6
3	6.78	"	222.0	205.0	282.0	161.0
4	7.0	"	43.7	59.9	69.3	45.0
5	15.0	"	1875.0	1770.0	2000.0	2310.0

Brush life is calculated on the assumption of one inch allowable brush wear. Brushes Nos. 2 and 4 are the two positive brushes of the generator and are on opposite brush arms.

The most interesting comparison is that between tests Nos. 1 and 2, which were made under identical conditions except that the former was made in air and the latter in hydrogen. In air the minimum calculated brush life was almost a year whereas in hydrogen it was only a little more than a week. Furthermore the damage to the commutator during the test in hydrogen was appreciable. The trailing edges of the commutator bars were burned away, in some cases as much as 1/32 in., leaving a bright metallic surface. This first test in hydrogen was quite unique in that it showed such a great difference in wear between the positive and negative brushes. Both tests described were made before a hygrometer was installed and consequently the relative humidity of the medium in which they were run is not known. It is very likely, however, that the test in hydrogen was started with a relative humidity of about 50 per cent and ended with a relative humidity of about 20 per cent.

Effect of Humidity

Tests Nos. 3 and 4 were made for the purpose of determining whether or not the unusually bad behavior of the brushes and the commutator in test No. 2 could be attributed to the high relative humidity which was suspected during this test. These tests were made with 30 per cent of the current shunted from the commutating-pole winding of the generator and the only difference in the two tests was in the relative humidity of the hydrogen atmosphere in which they were run. During test No. 3 the relative humidity was maintained at less than 10 per cent, whereas during test No. 4 the relative humidity was maintained practically constant at 50 per cent. Table I shows that the wear at the higher humidity was approximately four times as great as it was at the lower humidity. An inspection of the

From "Commutation and Current Collection in Hydrogen," (**No. 31-35**) presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1931.

commutator gave further evidence of improved performance during the low-humidity test.

Upon shutting down test No. 3 the commutator appeared dark and uniformly smutted, but apparently no damage had been done. A light application of fine sand paper showed the commutator to be in perfect condition. This however was not true of the commutator at the end of test No. 4. It was apparent immediately upon shutting down this test, that the commutator had been badly burned. The bright copper was showing on the trailing edge of the commutator bars just as it was after test No. 2, and the roughness could not be removed by any reasonable amount of sanding.

It is interesting to note that brushes Nos. 1 and 4 which were on the side of the machine nearest the moisture supply, showed somewhat shorter life than brushes Nos. 2 and 3 which were on the other side of the machine. In conclusion it may be said that if a commutator machine is running in hydrogen and sparking badly, the presence of moisture is detrimental to both the brushes and the commutator.

So far, all the tests described were made with the generator adjusted to give severe sparking at the brushes, the idea being to determine what would happen if this condition should arise in service. To show that operation in hydrogen may be quite satisfactory when commutating conditions are normal it only is necessary to refer to test No. 5, the results of which are tabulated in the last line of Table I. This test was made while the generator was delivering full-load current, but the shunt had been removed from the commutating-pole winding. The minimum brush life of almost five years and the good condition of the commutator at the end of this test would seem to indicate that as long as a machine is designed and adjusted for good commutation in air, it will behave quite satisfactorily in hydrogen. This last test was repeated several times and the same good results were always obtained.

Slip-Ring Tests

The apparatus used in these tests consisted of a collector or set of slip-rings driven by an adjustable-speed d-c. motor and so arranged that the space around the rings and motor could be filled with hydrogen. Each ring was 7/8 in. wide and 9½ in. in diameter and was trimmed with one brush 5/8 in. wide by 1¾ in. thick by 2 in. long. Direct current was supplied to the brushes and rings by an arc-welding set. Leads brought out through the bed-plate made it possible to measure the contact drop of any brush. Most of the tests were made with a current density of about 40 amperes per sq. in. and a peripheral ring speed of 2,500 ft. per min.

The first tests were made on a tool-steel ring trimmed with different grades of carbon and graphite brushes. The results of these tests were always the same. Lumps of hard material, sometimes 0.02 or 0.03 in. in diameter, were formed in the brush face and immediately began to score the ring. Upon analysis the hard material proved to be cementite (Fe_3C) which apparently had been formed by a direct combination of iron and carbon in the presence of localized high temperatures in the contact. In an attempt to prevent the formation of hard spots in the brush face, a helical groove was cut in the face of the tool-steel ring. With this change it was found that several brush grades which failed on the plain ring could be operated without difficulty; the formation of hard particles in the brush face was eliminated and the ring acquired a good polish.

These tests were quite similar to those made on the tool-steel ring and again the results were almost independent of the grade of brush used. When the air surrounding the rings was replaced by hydrogen all grades of carbon and graphite brushes showed a marked decrease in contact drop; in fact, the ratio of air to hydrogen was usually greater than ten to one. For most grades of brushes this reduction was permanent, although other grades after running for a while began to smut the ring; when this occurred the contact drop increased to about the same value as it would have in air.

No attempt will be made to explain the phenomenon disclosed by the above tests, but it was noticed that the results were peculiar to the particular brass ring on which the tests were made. Similar tests were made on the brass ring of another test set and it was impossible to even approach the low values of contact drop obtained in the first brass-ring tests. The only explanation which could be found for this disagreement in behaviour was the difference in the compositions of the two brass rings. This would also explain the fact that in the earlier tests the steel slip-ring showed only a slight decrease in contact drop when hydrogen was introduced.

Conclusions

It is realized that the tests reported in this paper are not very complete, but from the results of the tests described the following tentative conclusions may be drawn:

1. A commutator machine designed and adjusted for good commutation in air will operate satisfactorily and give good brush life in hydrogen.

2. If a commutator machine must spark in hydrogen the brush life may be increased many times by keeping the relative humidity below 10 per cent. This will also prevent damage to the commutator.

3. The contact resistance of carbon brushes on a commutator may be materially lowered by the introduction of hydrogen.

4. Carbon or graphite brushes cannot be operated satisfactorily on plain tool-steel slip-rings running in hydrogen.

5. The contact drop between a carbon or graphite brush and a brass slip-ring may be ten times as high when the ring is running in air as when it is running in hydrogen.

Evolving a Modern Protective Relay System

The history of a decade of experience with various kinds of protective relay equipment on one of the nation's largest electric service systems is outlined here. Conclusions leading to, and methods of accomplishing, a complete revision in system operating practise are discussed.

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PROTECTIVE RELAYS make possible a continuity of electric service under conditions which would have rendered such service impossible as little as ten years ago. Further, these sensitive devices permit improvements in transmission efficiency through enabling the safe use of lines in parallel with consequent reduction in $I^2 R$ loss, even though one line might have sufficient capacity to accommodate the load.

Previous to 1923 when the 150-kv. lines of the Southern California Edison Company, Ltd., were changed to 220-kv., no protective relays were employed. When a fault appeared the generator voltage was lowered and then gradually built up until the fault arc broke and ground currents ceased to flow. These faults resulted in service interruptions which could not be tolerated when the lines were changed over to the higher voltage. The decision was made therefore to install some form of relay protection. Phase relays of the induction type were so connected that two lines at a generating or substation were balanced against each other, both being under automatic protection. If it became necessary to remove one line of a pair from service, however, the other had to be made non-automatic, in which case the old scheme of reducing the generator voltage had to be relied upon. This plan while a great improvement over the older system of entirely non-automatic operation, was far from ideal, and the need for further improvement soon became apparent.

The first modification was in the form of balanced ground relays, similar to the phase relays already in service but designed to operate at lower-current values. This addition speeded up the clearing of heavy faults considerably, and provided further for the removal of faulty sections of line from the system when the ground current was too light to operate the phase relays.

With this combination of balanced phase and ground relays most faults were cleared without interruption to service; however, some interruptions still occurred when operating one line non-automatic, a practise still employed when one line of a balanced pair was out of service. Also, in a few cases when faults occurred during heavy-load periods the two ends of the system even after the fault had been cleared would sometimes drop out of step. This situation led to the installation of oscillographs and curve-drawing instruments several generating plants and substations to record transient conditions resulting from a fault. A study of records so obtained indicated a necessity for clearing the faults in a shorter time, limiting the ground current to as small a value as practicable, quick response of generator field excitation, and additional transmission line, only two 220-kv. lines then being in operation.

Protective Relay Installations—220-Kv. System

Table I shows the number of flashovers and other troubles on the 220-kv. transmission system from 1924 to June 1930. A study of the operating records from which this table was prepared demonstrated that at no time has there been any transient fault which has not been accompanied by a flow of some ground current. The wide spacing of conductors at this high voltage is responsible no doubt for the fact that the likelihood of phase-to-phase faults without a fault current to ground is rather remote. As a result of this situation, the practise of the past few years has been to abandon entirely the use of phase relays, depending solely upon ground or residual relays for protection.

TABLE I—220-KV. INTERRUPTIONS

Year	Number of faults	Faults cleared correctly	Number of times relays not in at time of fault	*System interruptions	Percentage system interruptions to faults
1924	22	8	13	14	63.8
1925	25	19	4	3	12
1926	36	27	1	8	22.2
1927	24	13	4	9	37.5
1928	26	18	5	7	27
1929	30	25	0	2	6.7
1930 Through June	20	18	0	0	0

*Due to load, severity of trouble, speed of clearance of trouble, location of trouble, system connections which determine source of power, and to protective relays being out of service.

Where two or more lines are connected to a generating plant or substation these lines are protected by induction, current-balanced relays connected in the residual connection of the bushing current transformers mounted

From "Development of a Relay Protective System" (**No. 30-191**), presented at the A. I. E. E. Pacific Coast convention, Portland, Ore., Sept. 2-5, 1930, and subsequently made available for publication.

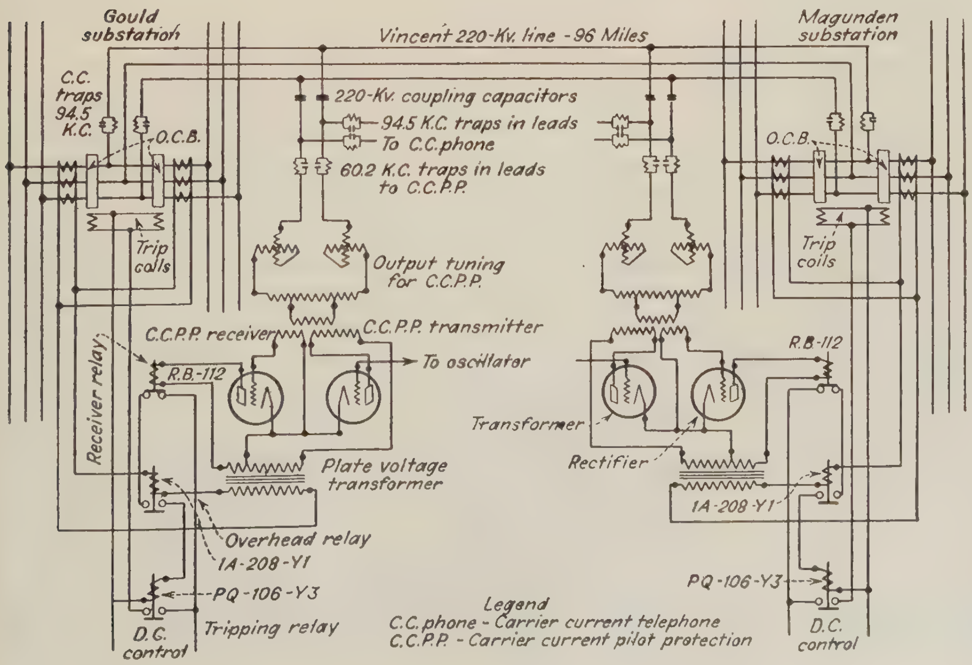
in the high-voltage oil circuit breakers. The relay scheme for single-line operation was changed to provide protection for a single line by means of residual directional relays actuated from the residual connection of the current transformers in the breakers and in the neutral or the residual connection of the station transformers.

The question of testing protective relays on important transmission lines has been a problem always, since to make an over-all test of the relays with the oil circuit breaker necessitated that a line be removed from service or be made non-automatic during the test. There have been a few cases of trouble when a section of line was operating non-automatic for relay testing. As a result it was decided to eliminate the possibility of an interruption from this source by installing duplicate sets of residual relays for each line, thus providing relays for each of the two oil circuit breakers controlling a line. This permits the testing of one set of relays with its oil circuit breaker, leaving the line under adequate protection with the remaining set of relays and oil circuit breaker. This latest scheme of protection completed in 1930 has been installed throughout the full length of the 220-kv. transmission system.

As a result of different routing and different substation connections, the company's third (Vincent) line between Los Angeles and the Big Creek plants has a current distribution somewhat different from the two other lines, and it has always been a problem to provide it with proper protection with the current-balanced relays which were satisfactory for the two original lines. The two terminals of one of the two sections of this line are switching stations not provided with any means of obtaining potential from the 220-kv. transmission line, and for this reason it was not possible to provide protection with power-directional relays. As a result of this condition, the carrier-current pilot protection was installed on the 96-mi. Gould-Magunden section of the 220-kv. Vincent transmission line and has been in service for nearly two years.

The carrier-current system is similar to the other forms of protection now in use on the 220-kv. system in that it provides for line-to-ground short-circuit protection only. It may be compared to the pilot-wire relay circuit, since the same net results are obtained. However, an exchange of relay-actuating current does not occur with the carrier system which operates instead to compare the direction of the two instantaneous residual currents at each end of the section of line affected. If the instantaneous residual current is in phase (in the same direction) indicating that a fault is external to the section protected, the equipment operates to lock out and prevent the induction overcurrent relays from tripping the oil circuit breakers. However, if the fault is in the section of line under carrier protection, current will flow towards the fault from the energy sources at each end of the section and the currents at the two ends will be approximately 180 deg. out of phase with each other. Under these conditions a fault within the section is indicated and the carrier-current receiver at each end is rendered automatically inoperative, permitting the induction overcurrent relays to function at both ends to clear that faulty section from the system.

Table II gives a summary of the results obtained with this protective equipment. When it is considered that the carrier-current system is an innovation in protective schemes, and that a great many problems had to be worked out before it was manufactured and installed, the results have been quite satisfactory. At each of



Schematic diagram indicating equipment and method involved in using carrier-current pilot protection system on a 96-mile section of 220-kv. transmission line

the two switching stations the section of the 220-kv. line so protected terminates in a set of two oil circuit breakers which connect to the two high-voltage buses at each station. Coupling between the 220-kv. Vincent line and the carrier-current pilot protection is obtained by means of oil-filled coupling capacitors connected to two of the three phase wires each connected from line to ground, giving what is termed "interphase" coupling. This coupling is made to the same phase wires at each end of the section protected, and the same set of capacitors is utilized for transmission of both the relay carrier frequency and the telephone carrier frequency over the same transmission line. Between the coupling capacitors and the 220-kv. oil circuit breakers at each station are installed carrier-current frequency traps built similar to a large choke coil and having a capacity of 800 amperes continuous duty with an inductance of approximately 70 microhenrys. Because of the double use of the capacitors, it is necessary to filter the protection carrier frequency and the communication carrier frequency into their proper channels.

TABLE II—SUMMARY OF OPERATION OF CARRIER-CURRENT PILOT PROTECTION ON A 96-MI. SECTION OF 220-KV. LINE

Total cases of trouble since carrier-current pilot protection installed	28
Cases of trouble exterior to section	20
Cases of trouble within section	8
Correct operations	26
Incorrect operations	2

The relatively heavy volt-ampere burden placed upon the bushing current transformers by the carrier equipment and the necessity of exciting that equipment from the secondaries of these transformers requires that to operate the equipment the fault current be 320 amperes or more. This rather high setting has been satisfactory, but if practicable it would be desirable to obtain a setting of from 200 to 250 amperes. Studies and experiments by the manufacturers now are under way which give promise of obtaining certain characteristics permitting the lower setting to be used. The overcurrent induction-type relay which is used is designed to operate at unusually high speed. To obtain for the carrier protection the greatest speed of operation consistent with a reasonable life of vacuum tubes, the filaments of all tubes are operated at approximately full voltage, but with no excitation on the plates. Experience indicates a necessity for making a transmission check of the equipment at frequent intervals, and provision to do this every two weeks has been made.

66-Kv. System Protection

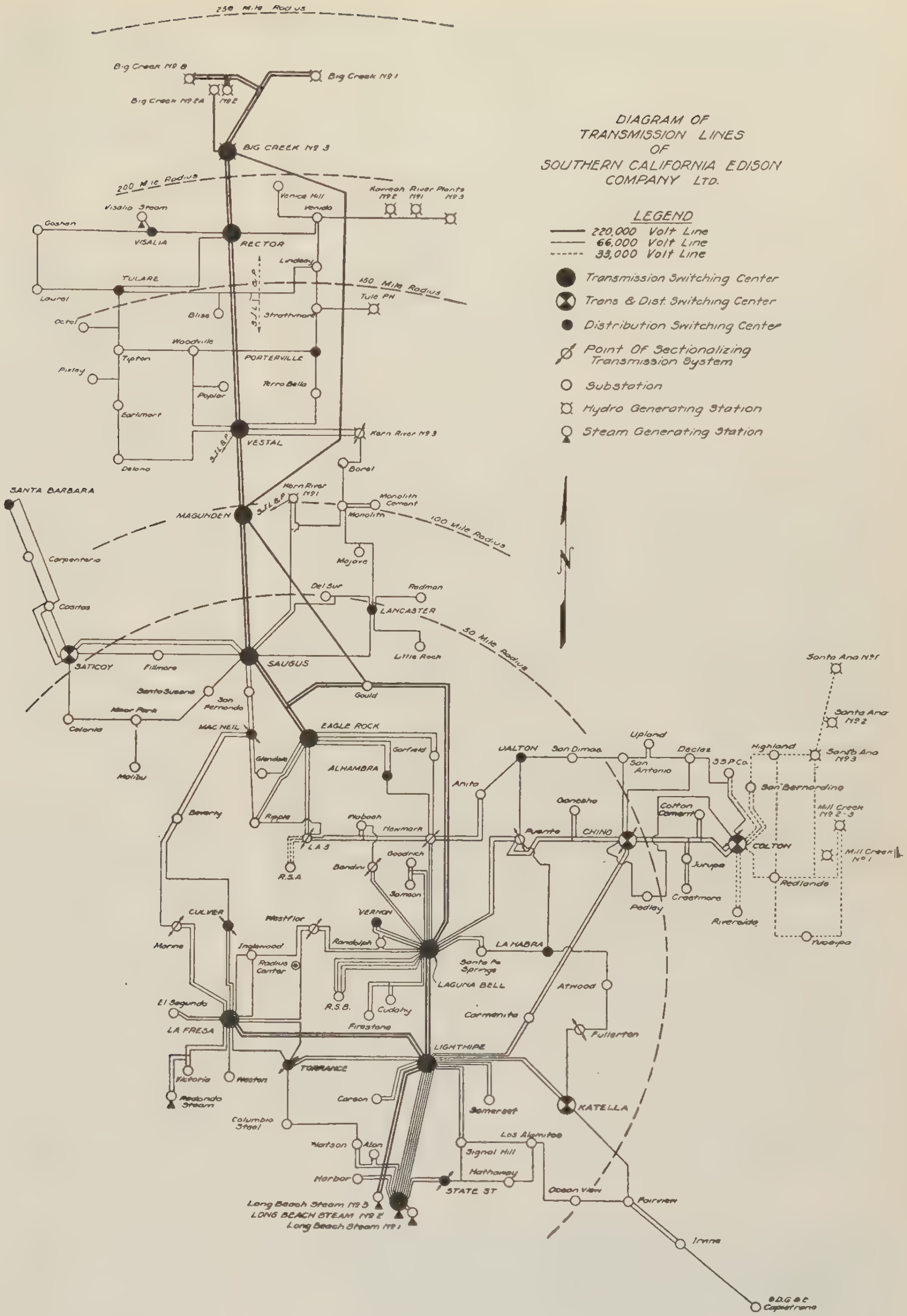
During the past few years the 66-kv. network of the Southern California Edison Company, Ltd., has been rearranged considerably particularly from the standpoint of routine operation and protection. Prior to some four years ago, the 220/66-kv. transmission receiving stations were interconnected quite closely on the 66-kv. side with the 66-kv. distribution stations looped into these connecting lines. The general practise was to have two or more incoming 66-kv. lines to each substation. Reliance was placed upon power directional relays to isolate faults, but because of the necessity of progressive timing for selective operation, the possibility of quickly isolating extremely heavy short circuits adjacent to the 220-kv. receiving stations became even more difficult. Accordingly in 1926 it was decided to begin changing the 66-kv. system from a loop to a radial system wherein each of the 66-kv. distribution stations would be supplied by two or more 66-kv. lines from one of the receiving stations. Furthermore, every effort was to be made to limit the phase-to-phase or phase-to-ground 66-kv. short-circuit current to approximately 1,000,000 kva. with an occasional exceptional upper limit of 1,500,000 kva.

With such a plan of operation it no longer was necessary to rely upon power-directional relays progressively timed; hence it was possible to take advantage of the characteristics of current-balanced relays wherein the currents in corresponding phases of two or more lines balanced against each other. This permitted a more prompt clearing of 66-kv. faults with consequent improvement in system operation. The decrease in the short-circuit current and particularly the increased speed of clearing short circuits due to the use of these relays has resulted in a marked decrease in a tendency towards system instability at the time of 66-kv. faults. As an adjunct to the line relays, current-balanced residual or ground relays when necessary have been installed and provision made to maintain protection by means of overcurrent or power-directional phase or residual relays for single-line protection.

16-Kv. and 11-Kv. System Protection

Heretofore the usual Edison method of providing for supply to 16-kv. or 11-kv. substations was by means of a separate feeder or a tap from a feeder radiating from a 66-kv. substation. During the past two years steps have been taken to provide two or more sources of supply to these lower-voltage substations, using either a scheme of loop operation between two 66-kv. substations or the preferred-and-emergency-supply method of operation. Recent analysis of the status of these lower-voltage substations supplied from the major 66-kv. stations shows that at present there are 35 distribution substations being operated on the loop system, of which 24 stations are operated on the 16-kv. system and eleven on the 11-kv. system.

A study of the cases of trouble experienced on lines supplying these stations shows that 38 cases of trouble were experienced during the first six months of 1930, and that 31 out of the 38 cases were cleared



Semi-geographic diagram of the transmission lines of the Southern California Edison Company, Ltd., showing the general plan of 66-kv. parallel-line supply to distributing stations adjacent to major receiving stations

correctly. In analyzing the seven cases which did not operate correctly it was found that two were caused by mechanical trouble in the oil circuit breakers, two by incorrect relay wiring, one by insufficient ground current, one by the d-c. trip circuit being de-energized, and one by unknown conditions. This record shows that there is room for improvement; however, results were so much more satisfactory than would have been experienced had the substations been supplied from a single radial line, as had been the practise in the past, that it is believed that loop operation of low-voltage distribution substations is successful and should prove a very efficient factor in minimizing service interruptions.

An analysis of experiences with the preferred-and-emergency scheme of operation shows that during the first six months of 1930 there were five cases in which the supply had to be changed over. In that period the only case of trouble experienced arose from a minor mechanical adjustment which caused one of the stations to fail to function properly.

Operating Experiences and Resulting Conclusions

For the past several years careful records of the performance of protective relays and automatic oil

circuit breakers have been kept by the Edison company; Table III is a tabulated summary of 1929 experiences. It may be noted that the trend is towards

TABLE III—OPERATION OF PROTECTIVE EQUIPMENT
220 Kv. to 11 Kv. Inclusive

	Year				
	1925	1926	1927	1928	1929
Cases of trouble	1493	2185	1799	1415	1303
Automatic switch operations	2368	3231	2831	2085	1923
Unnecessary switch operations	278	316	287	151	70
Failure of switches to operate	50	47	48	25	33

fewer cases of trouble and consequently, generalizing, fewer automatic switch operations. There has been a decided decrease in unnecessary switch operations, which shows the result of wider application of protective relays with better knowledge of their characteristics and limitations. Intensive studies of the magnitude and distribution of phase-to-phase and phase-to-ground short-circuit currents have been of immense value in determining proper relay settings for various types and locations of faults.

Decrease in "failure of switches to operate" has not been as marked, but these failures in general are the result of some form of trouble on the tripping side of the protective relays. A tripping coil may become defective, an auxiliary switch in the tripping circuit may not be making proper contact, mechanical faults may develop in the oil circuit breaker operating mechanism, or the control wiring may be defective.

A program of inspection, testing, and careful maintenance of the oil circuit breakers, protective relays, and tripping circuits is the only means of lessening these "failures to operate." Summing up in brief the results of operating experiences with the 9,300 protective relays now installed on the Southern California Edison system, the following conclusions seem warranted:

(1) In the interest of assuring a more reliable performance of the protective relays on the 220-kv. transmission system under conditions of testing and overhauling the protective equipment as well as during normal operating conditions, duplicate sets of relays are installed. This permits protection to be retained at all times.

(2) Use of carrier-current pilot protection on a 95-mi. section of 220-kv. transmission line has been satisfactory and has shown the value of this form of protection under conditions which would not permit the use of other forms of protective relays.

(3) Use of current-balanced relays and radial lines between the 220-kv. major receiving stations and the 66-kv. distribution stations has been an improvement over the previous practise of looping through the 66-kv. stations between adjacent 220-kv. stations. Elimination of the necessity of depending upon progressively-timed power-directional relays has speeded up the time required to clear faults.

(4) The practise of looping 16-kv. and 11-kv. distribution stations between adjacent 66-kv. stations in place of the previous practise of using single radial lines has resulted in a marked improvement in service.

(5) In rural districts the use of a remote alarm between unattended and attended stations to indicate when an oil circuit breaker trips out at the unattended stations has lessened the time of outage considerably. Private telephone lines or carrier-current equipment coupled to the transmission lines permits the installation of this remote alarm at a reasonable expenditure.

Allied Considerations

Successful application of protective relays on a transmission system is so closely linked with the static and transient stability of the system that whenever relays are involved consideration must be given to these characteristics. Stability is the limiting feature of long high-voltage transmission lines which determines the amount of power possible to handle commercially. It is obvious that the stability of a transmission system is determined by the longest section of line which may be isolated suddenly from the system to clear a fault. The static stability limit can be calculated readily to make it plain that if the power demand is such that the reduced transmission line capacity will not hold the generating and receiving ends of the line in synchronism, instability will result. Determination of the transient stability limit does not readily permit a definite solution since the factors to be considered cannot always be obtained with desirable accuracy. However, there is a number of outstanding features which can be considered and applied to a transmission system which will help greatly in maintaining stability under conditions of heavy short-circuit currents. Briefly stated these are:

1. Prompt clearing of faults is of prime importance in minimizing the loss of synchronism between the generating and receiving ends of a line.

2. A high short-circuit ratio (between 1.5 and 2) in generators and synchronous condensers aids materially in improving system stability.

3. Quick response or super-excitation for the fields of synchronous machines assists in maintaining transient stability.

4. The desirability of limiting ground currents so as to reduce the power demand on the transmission system at the time of faults is well established. This can be accomplished by installing current-limiting reactors in the transformer neutrals.

5. Momentarily decreasing the output of generators at the sending end of a long line at the time of faults reduces the likelihood of the two ends of the line dropping out of step.

6. A knowledge of the stability characteristics of the load supplied is helpful in making line stability calculations.

7. In studying relay problems or predicting inductive interference ground impedance along the line must be considered.

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Resistance Welding Improves Motor Frames

The ever present demand for cost reduction calls for continual revision of manufacturing methods. Motor frames as now made from rolled plate instead of castings as formerly used represent one such revision. Manufacturing methods are outlined here; oscillographic records reveal something of the character of a resistance flash weld.

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ELECTRIC WELDING in its various phases has been the means of reducing the manufacturing costs of many industrial products. Three methods of welding are in common use today; namely, the carbon arc, the metallic arc, and the resistance methods. Of these three the resistance method has proved to be especially adapted to the welding of electric motor frames, having been used for this purpose since 1928. In this way motor frames can be fabricated from structural steel at a marked saving in cost as compared to corresponding cast-steel frames. In addition, these welded frames possess the distinct advantage of greater uniformity in both dimensions and structure.

Steel of the proper width and length for the rings, and with necessary allowance in length made for welding and sizing operations, is ordered from the mills in carload lots. That which has been found most suitable for magnet frames is a basic open-hearth-process steel of low carbon content. The slabs of the various sizes required for different sizes of magnet frames are unloaded at one end of the department; these are passed to a 1,200-ton hydraulic press which crimps or curls the ends to avoid flats and waste of stock at portions which cannot be rolled.

A view showing the steel as purchased and also illustrating the various steps in fabrication is given in Fig. 1. A typical ring in bending rolls is shown in Fig. 2. Attention is called to the vertical plate which insures accurate alinement of the ends of the ring during the rolling process. Electric motor drive is provided for raising and lowering rolls, as well as for the rolls themselves. The end section is pivoted and controlled by an air cylinder as shown in the figure, thus providing for quick removal of the rings.

From the rolls the rings pass by conveyer of considerable storage capacity, to a specially designed resistance flash welder of the Thomson-Gibb type. In Fig. 3 this welder is shown in action. The rings are held in place with powerful clamps actuated by hydraulic cylinders against special aluminum bronze die blocks. The operator first separates the ends of the rings slightly; then starts slowly feeding the jaws of the machine together with a hand-valve control of the hydraulic push-up cylinder.

Current is turned on by a push-button actuating a small contactor which in turn controls a large contactor, the latter closing the connection of the primary of the transformer to the power lines. As the ends of the ring meet, first a feeble, then a violent flashing occurs. A predetermined amount of metal is flashed off, averaging slightly less than an inch total. The abutting faces are brought to the melting point of the steel by the flashing process whereas the areas immediately behind are brought to a welding heat mainly by conduction, but partly by resistance. At the end of the flashing period, the full pressure of the hydraulic ram, which is about 100,000 lb., is applied, suddenly forcing the molten faces together. The result is a perfect and homogeneous weld, all burnt or oxidized metal being forced out. This welder while rated at 12 sq. in. cross-section maximum, is sometimes used on sections up to 18 sq. in. The welder has a 750-kv-a. water-cooled transformer with an open-circuit voltage of 12 at the welding jaws.

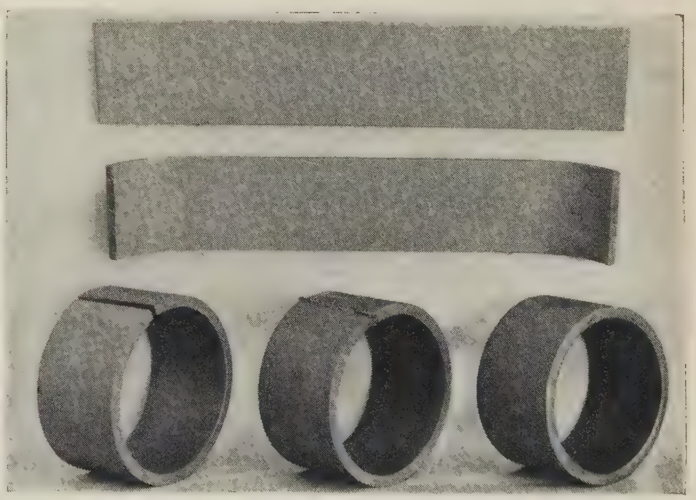


Fig. 1. Successive stages in fabrication of electric motor frame from structural steel slabs

From "Resistance Welding of Motor Frames," (**No. 31-6**) presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1931.

Due to the severe nature of the service, the demands on welding transformers require special features of design. The service is intermittent but large amounts of current are necessary, particularly at the final or upset period of the welding cycle. In order to facilitate repairs, accessibility is an important feature; hence the coils are usually assembled on a straight core section, a U-shaped section being then placed in position and fastened with bolts and straps to the straight section. On 60-cycle supply the core is worked at a flux density of from 60,000 to 80,000 lines per sq. in.

The secondary of this transformer consists of a single turn usually of cast copper with tubes for cooling water included in the casting. In larger transformers several cast-copper sections are often connected in parallel. The ends of the copper secondary are machined, one end being fastened solidly to the fixed platen. The other end is bolted to a flexible lead made up of many thin sections of copper strip, this lead being connected to the movable platen. The welding dies are located on top of the platens and are made of hard-rolled copper or special wear-resisting material, depending on the nature of the service for which they are intended. The work is very solidly clamped to these die blocks because of the push-up pressure required. The cast copper is worked at a current density of from 1,800 to 2,200 amperes per sq. in., the flexible leads at from 2,000 to 2,400 amperes and the joints at from 400 to 600 amperes per sq. in. The dies are worked at about 3,000 amperes per sq. in. current density. Wherever possible dies and platen as well as the transformer secondary are water-cooled internally and to avoid any unnecessary voltage drop the length of the secondary circuit is kept at a minimum.

Primary coils of the larger type transformers are usually built up of copper strip insulated between layers by a sleeve cloth or layer of asbestos paper. The coils are impregnated and baked; then wound with tape and finally painted.

Voltage regulation on the primary is obtained either by use of a separate auto-transformer or by bringing out taps to a regulating switch. Usually there are from five to ten points of voltage regulation, the lowest being about 50 per cent of the highest. Since on production work the breaking of the current may occur several times per minute, contactors used to switch on the power supply must be able to break full load of the welder without undue arcing or overheating.

Readings taken while welding a section of 18 sq. in. show that a primary current of about 900 amperes is required during the flashing period with a peak load of 2,250 amperes at the final or completion period of weld when the ring is forced together. The primary voltage at the time of these readings was 236, the transformer being supplied from a 60-cycle circuit. At high point

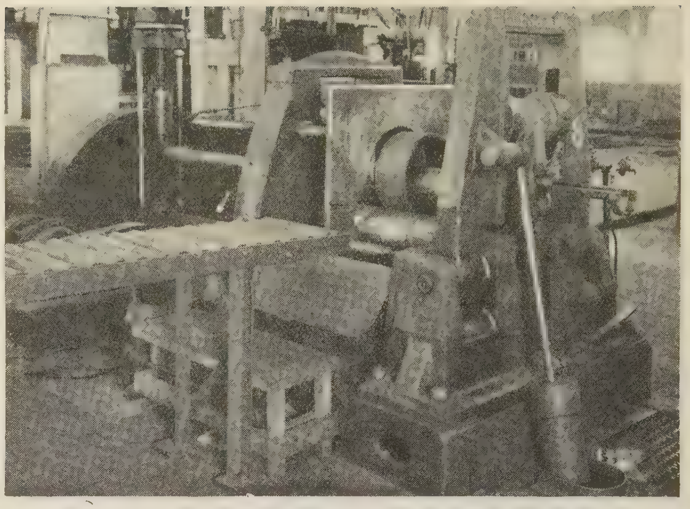


Fig. 2. Rolling machine for forming steel slabs into rings for motor frames

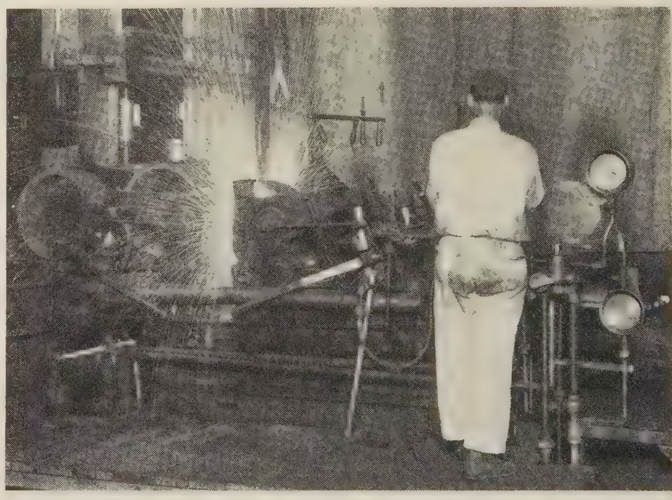


Fig. 3. A Thomson-Gibb resistance flash welder in operation. Magnetic field expels molten particles rather forcefully upward

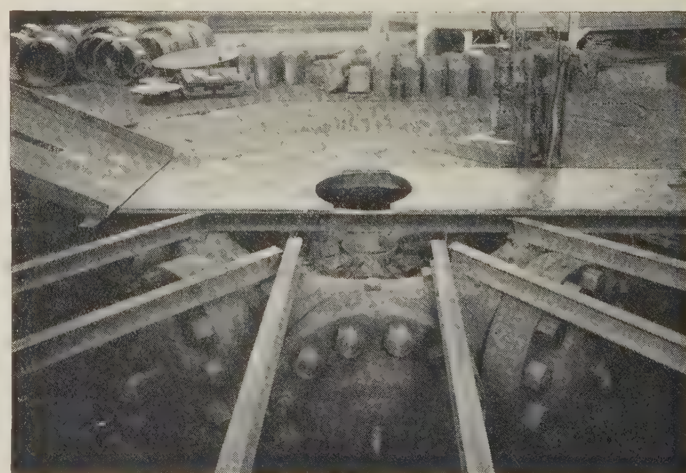
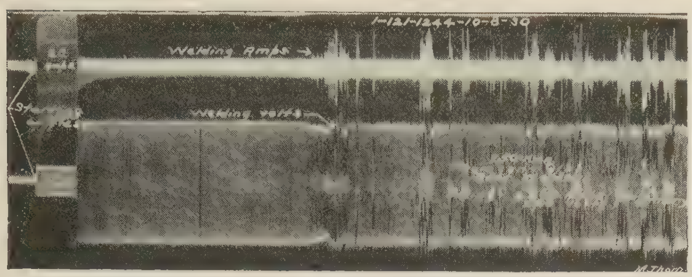


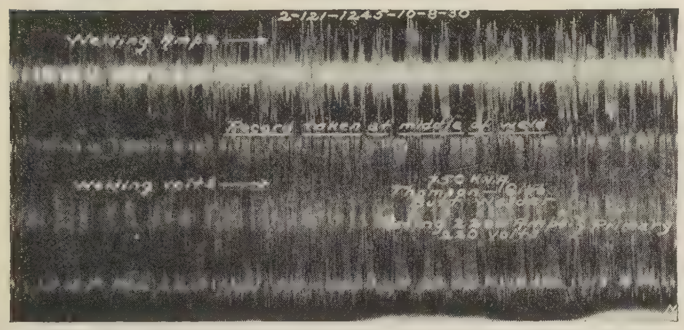
Fig. 4. A hydraulic press for sizing welded frame rings

of weld, readings taken show a maximum of 461,250 volt-amperes and 252,000 watts power consumption, which gives a power factor of about 55 per cent. The average during flashing was 126,000 watts; power consumption with the secondary open, 1,400 watts.

A



B



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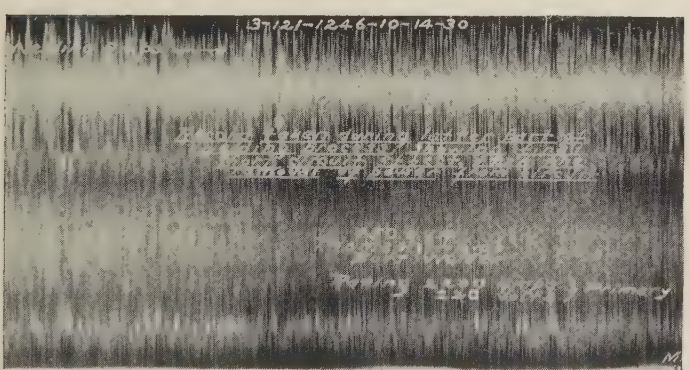

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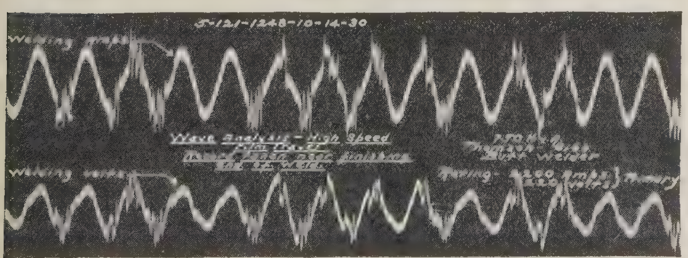

Fig. 5. Voltage and current relations at various stages in process of resistance weld. From top to bottom: beginning of flash period; middle of flash period; final stages; and wave analysis near close of flash period

Oscillograph records made on this welder are reproduced in Fig. 5. *"A"* shows conditions at start of flash, which consists first of a brief interval of short circuit, and then open circuit followed by beginning of contact of pieces. This represents a period of feeble flashing. As the flashing becomes more violent, conditions are as shown in *"B."* Toward the end of the flashing period, as shown in *"C"* when flashing appears continuous, the wave form still shows no continuous flow of current, but rather closely compact intervals of short circuit and open circuit. This picture also shows the upset or final push-up section of weld. A high-speed oscillogram made near the end of the flashing period is shown in *"D."* This illustration shows in some detail the intermittent nature of current during this period of the weld.

After the welding operation is completed, the ring is removed from the welder by an electric hoist. The upset resulting from the welding operation is removed by a vertical motor-driven broach which trims both the outside and inside of the ring while the metal is still red hot. The rings then pass by a conveyor similar to that previously mentioned, to an electric furnace. The electric furnace operation, while primarily used for heating rings for sizing, is advantageous also in that it gives the rings a strain anneal.

Rings are heated in this furnace to about 1400 deg. fahr. and then pass down a slide to an eight-cylinder hydraulic press located in the floor of the plant as shown in Fig. 6. (Part of the flooring has been removed to show the construction of the press.) It may be noted that in order to accommodate various sizes of rings this press is so built that each cylinder has a removable head portion. Rings are lowered horizontally into the press by means of an air-operated table and are then squeezed to within from 1/16 in. to 3/32 in. of correct size, depending on the size of the ring.

The frames are now complete with the exception of feet. The feet are made from steel bent into a "U" form in a hydraulic press, and are then cut apart by means of a gas torch. Each "U" makes one pair of feet and by inverting the "U's," right and left pairs are obtained. It is customary to cut all four feet at once using a double-torch machine for this purpose.

The sized rings pass by another conveyor to arc welding stations where the feet are tack-welded, then finish-welded into place. The completed frames are then sand-blasted, after which they are shipped to the motor building for machining and assembly.

By the use of electric welding of two kinds it has been possible to produce frames from 25 to 50 per cent cheaper than corresponding steel castings, with the added advantage of much greater uniformity in dimensions and structure. This, in turn, reflects a lowering of the machining costs and the production of better motors.

Low-Frequency Induction

The present status of joint development and research on low-frequency induction as it affects the closely associated circuits of the electric service and the communication utilities is outlined here.

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INVESTIGATIONS being carried on by the Joint Subcommittee on Development and Research of the National Electric Light Association and the Bell System are in large measure concerned with induction at power-system fundamental frequency, its disturbing effects on communication systems, and remedial measures. This commonly-called low-frequency induction, has different characteristics and produces quite different effects from induction at noise frequencies as discussed in a companion paper by Messrs. Blackwell and Wills. Since very little has been published on low-frequency induction, it seems desirable to explain the problem in some detail in order to make clear what the joint subcommittee on development and research is doing on this subject.

Low-frequency inductive disturbances rarely occur under normal operation but are due usually to large unbalanced (residual) currents coincident with accidental faults in the power system. Although such abnormal conditions occur infrequently and usually last for only very short periods, the effects may be so serious that protection against this type of induction is an outstanding problem in the coordination of power and telephone systems.

Residual voltages and currents in effect are single-phase voltages and currents acting in a circuit consisting of the three line conductors in parallel as one side and the earth as the other side. Their large inductive effects are due to the great separation between the two sides of this earth return circuit, much of the return current being effectively so deep in the earth that its neutralizing action is small. The magnitude of these residuals is determined by (1) the power voltage and supply; (2) the impedances of lines, apparatus, earth, and fault; (3) configuration of conductors; and (4) characteristics of ground wires. Their frequency of occurrence depends upon the design and quality of construction employed, and upon the nature of external influences. Their duration is controlled by the effectiveness and speed of the relays and circuit breakers.

From "Status of Joint Development and Research on Low-Frequency Induction," (No. 31-23) presented at the A. I. E. E. winter convention as Part III of a symposium on coordination of power and telephone plant.

The magnitude of the voltages which these residuals induce into the communication circuits is principally determined by the location of the fault and magnitude of the residual current, the length of the exposure, the separation between power and communication lines, the location of ground connections on the two systems, and geological conditions affecting earth conductivity.

Typical Example

As illustrative of the effect of each of these factors, consider an exposure between a three-phase 26-kv. power line and a telephone line: The configuration of the conductors on the power line is an equilateral triangle, 30-in. spacing, conductors 250,000-cir. mil copper, height above the ground 40 ft., fault or residual current 1,000 amperes with the fault-to-ground at the end of the exposure. The exposure is five miles long with a uniform separation of 40 ft. between the power and telephone lines; height of the telephone line 25 ft. The assumed conductivity of the earth is 10^{-12} abmhos per cm. cube. Under these conditions, the induced voltage in the telephone line will be 1,870 volts. The effect of a change in the different factors on the induced voltage on the telephone line is as follows:

	Condition	Induced Volts
1.	Length of exposure doubled (10 miles)	3,740
2.	Residual current reduced to 500 amperes	935
3.	Residual current reduced to 200 amperes	374
4.	Separation increased to 60-ft.	1,700
5.	Separation increased to 3,000-ft.	34.5
6.	Earth conductivity 10^{-13} abmhos per cm.^{3} (40-ft. separation)	2,530
7.	Earth conductivity 10^{-14} abmhos per cm.^{3} (40-ft. separation)	3,200
8.	Earth conductivity 10^{-13} abmhos per cm.^{3} (3,000-ft. separation)	280
9.	Earth conductivity 10^{-14} abmhos per cm.^{3} (3,000-ft. separation)	792
10.	2/0-copper shield wire, grounded at both ends, installed on power line (zero ground resistance)	925
11.	2/0-copper shield wire grounded at both ends, installed on power line (5 ohms ground resistance)	1,370

Low-frequency and transient voltages induced on communication circuits may produce a variety of effects depending upon their magnitude and duration. These effects may include interruption of service, false signals, distortion of telegraph signals, damage to central office or other plant, acoustic shock, and electric shock.

Of the protective measures which reduce inductive influence, some are concerned with fundamental questions of power-system design; others with changes in circuit or grounding conditions, lines, equipment or operating methods. It is evident that protective measures to reduce the inductive influence of power

systems should be directed to limiting the magnitudes of the unbalance currents and voltages, particularly under abnormal conditions, and to reducing the duration and frequency of occurrence of abnormal conditions. Some of these protective features are preferably incorporated in the system when constructed as a result of cooperative advance planning, while others may be added later to care for effects due to subsequent developments in either the power or telephone system.

Power System Protective Measures

Protective measures in the power system, which are available or under investigation for mitigating or eliminating these effects, are briefly described below.

Reduction in the frequency of occurrence of faults involves primarily the design and construction of the power line; that is, adequate insulation, clearance and spacings, and so arranging the component parts of the structure that the line will in effect be fault resistive. The principal elements which enter this problem are (a) design and spacing of conductors including ground wire so as to prevent arcing between them under expected conditions of sleet and wind loading, (b) proper mechanical strength of structures to withstand expected loading and (c) design and location of guys so as to provide adequate mechanical strength and at the same time make the minimum reduction in clearances and insulation.

The proper location of lines is a material factor in limiting the number of outages resulting from external sources, such as lightning, broken trees, blasting, and automobiles. The amount of insulation to be employed on lines should be governed by topographical and climatic conditions, and special attention should be given to areas where salt, fog, smoke, or chemical fumes are prevalent.

Resistors or reactors in the neutral ground connection of a power system provide a means of directly limiting the magnitude of the residual currents except in cases of double faults. In cases where without reacting unfavorably upon power system operation, the residual currents can be so far reduced as not to set up induced voltages of high values in the communication system this method alone may afford a satisfactory solution. In such cases it has the further advantage of reducing the stresses to the power system due to the fault current. Where it is impracticable to clear up a situation by residual-current limitation alone, this method may be effectively used in combination with other protective measures. Included in this work is a study of the relative advantages of inductance as compared with resistance for accomplishing such current limitation.

In non-grounded power systems a single fault on a phase conductor results in the charging current of the system flowing to earth through the fault. The other phases, rising to full-line voltage above the grounded phase, create a system unbalance which may manifest itself by induction in paralleling communication lines. In such cases the problem is one of electric induction except for the magnetic induction set up by the charging current.

Ground wires on a power line, while tending to increase the total residual current, serve the purpose of shielding by reducing the strength of the external electric and magnetic fields set up by the residual voltages and currents. The net effect of ground wires from the low-frequency standpoint is to reduce the voltages induced in paralleling communication circuits under abnormal power-circuit conditions. Such ground wires, if used on wood-pole lines, have a disadvantage in that they impair to some extent the insulating property of the poles.

High-speed breakers and relays are expensive and it is difficult to justify them solely as a remedial measure for induction, particularly as the speeds of operation now available for relays and breakers on power systems have not reached values which make them a complete solution of coordination problems. However, with the increasing size and interconnection of power systems, high-speed relays and circuit breakers are playing an increasingly important part in promoting power system stability.

The subcommittee is following the developments in high-speed breakers and relays with much interest; if such devices should come into general use for all classes of service it is expected that they will materially improve the whole inductive situation.

Telephone System Protective Measures

In general, measures applicable to the communication system to prevent or reduce the effects of induced voltages take the form of arrangements or devices for removing or counteracting the voltages to ground or the currents in the telephone circuits which might be produced by induced voltages.

Protective measures in the communication system which are available or under investigation are briefly described as follows:

Bell System standard protective devices are intended to offer a measure of protection against lightning discharges and against the voltages and currents resulting from accidental contact with foreign wires, or from low-frequency induction.

In order to protect telephone linemen or others working on open-wire lines against electric shock from induced voltages, it is necessary that the voltages between line wires and between each line wire and ground be kept low. The use of protectors at central offices does not so protect the linemen as the impedance drop on the line wires permits high voltages between wires and ground at other points, such as the terminals of the exposed section.

In view of the inadequacy of existing forms of protectors for such use, the subcommittee is experimenting with a relay protector. This device includes Bell standard protectors in combination with a relay which operates to short-circuit them upon the occurrence of a discharge, thus relieving the protectors of the duty of carrying the large discharge current and greatly reducing their tendency to become permanently grounded.

The effective application of such protectors requires grounds of the order of one to two ohms, and an important feature of the investigation is to devise methods of constructing and maintaining such grounds at remote points along the line.

Since acoustic shock due to induced voltages involves dissymmetrical discharges across the two sides of the protector, efforts have been made to devise a protector which would break down and discharge symmetrically; *i. e.*, provide two reliable, low-impedance paths for heavy discharges which would at all times have very closely the same arcing impedance. Thus far the subcommittee has not been successful in developing a practical protector of this kind. In cases where toll or trunk lines are exposed, an acoustic-shock-reducing device which could be placed at the ends of the lines would have the advantage of protecting subscribers as well as operators. Development work to obviate certain difficulties in using such a device is under way and effort is being made to develop a telephone receiver which will saturate between the values of current required for effective speech transmission and values of current which produce acoustic shock. This requires a sharp bend in the saturation curve of the iron employed in the receiver magnetic circuit. Until the development of permalloy, this feature was not approachable, but experimental permalloy receivers have now been developed, and while it has not yet been possible to achieve the end sought without serious sacrifice in transmission, work along this line is continuing.

Drainage is a method for controlling the parts of the circuit in which the induced voltages appear, and causing these voltages to be consumed in parts where they are least harmful. This is accomplished by connecting the telephone conductors to ground (preferably through balanced impedance coils) at certain points throughout the exposure. Under present conditions, the application of drainage is limited to special situations where interference with circuit testing and maintenance is of relatively minor importance, and where superposed d-c. telegraph and carrier telephone are not used.

The neutralizing transformer is a device for introducing into an exposed communication wire a voltage in opposition to the voltage induced by the disturbing circuit, thereby to a certain extent neutralizing the latter. On account of introducing crosstalk, and adversely affecting telephone transmission and carrier, application of neutralizing transformers has been confined chiefly to telegraph circuits. They are being studied by the subcommittee to see whether or not the objections mentioned above can be overcome; also to determine their field of possible application.

Shielding on a telephone line may be effected by special grounded conductors, by working conductors or by cable sheaths. Miscellaneous structures such as pipe lines or rails in the immediate vicinity of an exposure also introduce more or less shielding. If the lead sheath of the cable is surrounded by magnetic material, as by armoring or placing cable in iron pipe, the shielding may be largely increased.

As bearing on the prevention of electric shock from induced voltages on telephone lines, shielding has a disadvantage, in that depending somewhat on the method of construction, it may add to the chance of a lineman making contact with grounded metal.

Coordinated Protection

Joint measures which may greatly obviate the ill effects of low-frequency induction are: Coordinated advance planning in order to effect the most advantageous location of new lines, and coordination of grounding practises to obtain separation of power and communication ground connections.

The ideal protective measure would be one which furnished adequate protection and had no unfavorable reaction from an economic or service standpoint on the system to which it is applied; however, the work thus far has not disclosed any measure which fully meets this ideal. The relative advantages of different protective measures differ in specific cases. The best solution for any case is the one which correctly balances technical results against over-all cost. Adequate separation of circuits is the most effective measure, but where this is not practicable, fault current limitation in the power system, and cable (particularly if shielded) for the communication circuits, afford the most generally effective protection (where applicable). In many situations, no single protective measure is adequate and two or more in combination are required.

As telephone circuits which are exposed to induced voltages may also be exposed to possible contact with power circuits and to lightning, any comprehensive scheme of protection must include consideration of the high currents resulting from contact and the high voltage due to lightning. The voltages produced by contact or lightning are somewhat similar in their effects to the voltages produced by induction, but differ in many important respects: Lightning requires protectors of a very high speed of operation, whereas contacts with power circuits necessitate protectors of high-current carrying capacity.

The program of work on low-frequency induction, undertaken by the Joint Subcommittee on Development and Research through its project committees, is laid out to develop the essential facts bearing on the problem of telephone protection in a broad sense, in-

cluding causes, effects, and remedial measures. The program covers both the technical and the economic aspects of the problem.

Extensive field trials of the more promising protective measures are under way in order to determine their practicability under operating conditions. As the work progresses it is expected to issue from time to time reports covering the applicability, efficacy, limitations and conditions of use of various measures. This should result in a better understanding of the problem and more effective and economical solutions of specific situations as they arise.

A bibliography listing 32 of the more important writings on this subject which have come to the attention of the authors is given as a part of the winter convention paper of which the foregoing is an abstract.

Noise-Frequency Induction

The present status of joint development and research on noise-frequency induction as it affects the closely associated circuits of the electric service and the communication utilities is outlined here.

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OFTEN IT HAS been remarked that few problems are difficult to solve if all the facts bearing on them can be determined. The work of finding out the technical facts bearing on the problems of the physical relations of power and telephone circuits was intrusted to the Joint Subcommittee on Development and Research of the National Electric Light Association and the Bell System. This paper has to do with this fact-finding work so far as it concerns noise-frequency induction.

This joint subcommittee has subdivided its work among eleven project committees and has assigned to each the carrying on of specific research problems. It is not possible in the scope of this paper to discuss these various project committees and their work in detail; for the most part, results of the work of these project committees which have been published, or will be published in the future, must speak for them. The work on inductive coordination may be classified into three groups of factors:

1. Influence factors which concern the characteristics of the power circuits.

2. Susceptiveness factors, which concern the characteristics of the communication circuits.

3. Coupling factors, which concern the interrelation of power and communication circuits.

Before discussing these groups of factors it will be of interest to review the subject briefly from another point of view; namely, according to the methods which may be employed for the control of inductive interference. These methods are as follows:

Where two systems react unfavorably on each other, the first thought naturally is to keep them apart physically. In cases where the operating power and communication companies maintain close contact in their planning work, this may be a most effective method of handling coordination of important power-transmission lines and toll-telephone leads. With local distributing power and telephone systems, however, the need for serving the same customers requires that the systems be close neighbors. In connection with the matter of physical separation it should be noted that while a separation between lines of a few hundred feet practically eliminates the noise frequency problem, the low-frequency problem may exist with much greater separations. Where physical separation cannot be brought about, the methods of coordination employed must be along the lines of electrical separation. There are here three possibilities: Frequency separation, electrical balance, and shielding.

The idea of electrical separation by use of different frequencies is familiar to nearly every one today because of the development of radio broadcasting. It is happily true that the frequencies used for power transmission are comparatively low, and the frequencies necessary for good speech transmission are ordinarily well above this range. The figure shows a diagram of the various uses of the frequency spectrum for electrical transmission, and the manner in which power and telephone services are coordinated by frequency separation.

An important part of this matter of frequency separation is evidently the question of wave shape in the power systems and the relative amounts of power employed in the two systems. While the amounts of power at harmonics of the fundamental frequency in power circuits are negligible in comparison with the total power transmitted, they are large compared with the

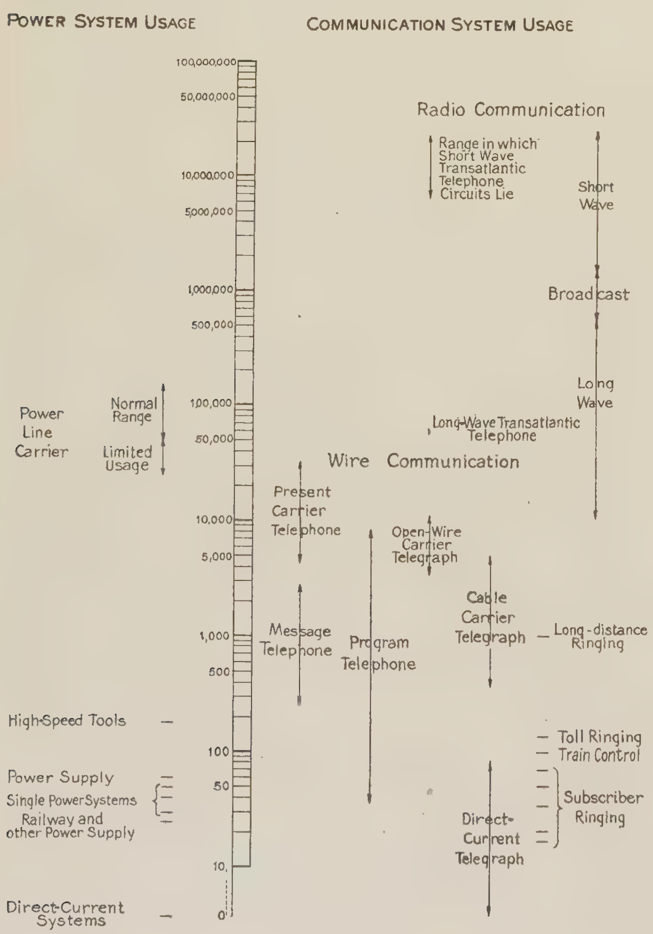
From "Status of Joint Development and Research on Noise-Frequency Induction," (**No. 31-22**) presented at the A. I. E. E. winter convention Part II of a symposium on coordination of power and telephone plant.

power employed in the telephone circuits, and fall directly within the frequency range used for telephone transmission. On the other hand, while the powers involved in telephone transmission are small compared with those on power lines, they are, in turn, large as compared with the acoustic power received from the talker or delivered to the listener.

Electrical balance is another fundamental means of bringing about electrical separation. A perfectly balanced power circuit could not influence an adjacent communication circuit; nor could a perfectly balanced communication circuit be interfered with by a power circuit. Perfect balance, however, is a virtue which is difficult to obtain, and the problems of balance in electrical circuits present some of the most interesting and difficult technical questions being considered.

Shielding is a third possible method of electrically separating two systems. The different wires of a telephone line have an important shielding effect on each other. The most important practical phase of shielding is the use of lead sheaths on telephone cables which have a most important effect in practically eliminating electric induction in the cables. The method is limited, however, by the difficulty of bringing about a comparable degree of magnetic shielding.

FREQUENCIES USED FOR ELECTRICAL TRANSMISSION



Returning to the method of analyzing inductive coordination into influence, susceptiveness, and coupling factors, the important influence factors of power circuits are wave shape and unbalance on the operating voltages and currents. Wave shape is determined by the characteristics of the apparatus associated with the system; and balance is determined by the degree of symmetry of the generated voltages and of the apparatus load and line impedances. In order to obtain a broad picture of the wave-shape conditions that exist in the field of operating power systems equipped with various types of apparatus, an extensive survey was made including measurements on 34 operating power systems in the eastern half of the country. The program was arranged to obtain information as to the average and range of magnitudes of harmonics present in various types of transmission and distribution systems under normal operating conditions; to observe the relation between the wave shape of generating machinery under open-circuit conditions and under load; to study effects of various transformer connections on wave shape, and to observe the effects of various types and magnitudes of load. The data accumulated are being summarized in technical reports which will be published upon their completion.

The important sources of unbalance in power circuits are (1) triple-harmonic residual voltages and currents arising with rotating machinery or transformers connected in star with neutral grounded; (2) differences in the loads connected between the phase wires and neutral of three-phase four-wire distribution systems; and (3) differences in conductor capacitances-to-ground due to single-phase branches on three-phase systems.

Experience has indicated that the outstanding factor is the existence of the triple-harmonic residual voltages and currents. A large measure of control may be exercised on the magnitudes of the triple harmonics by the use of certain transformer connections and by avoiding the operation of transformers at high flux densities.

A technical report has been published dealing with noise-frequency induction which arises when star-connected generators operating with grounded neutrals are connected directly or through star-star transformer banks to transmission or distribution systems. Information is given on methods of reducing the influence under such conditions.

A laboratory study of transformer harmonics and transformer connections is under way; this is to be supplemented by tests on large transformers in the manufacturers' shops and in the field.

The important susceptiveness factors of telephone circuits are unbalance, sensitivity of the receiving apparatus, and operating power level of telephone circuits.

Unbalances in toll circuits are the result of commercial variation from the balanced condition, the circuits being designed to be symmetrical. These unbalances

include resistances in joints, transposition irregularities, and differences in the impedances of shunt or series apparatus.

Because of the shielding effect of the telephone cable sheath, the high degree of balance of the terminal apparatus and the more general use of private rights-of-way, cases of noise-frequency induction into toll-cable circuits are comparatively infrequent.

Certain unbalances exist in exchange circuits due to the arrangements used for selective ringing, for coin box service, and for supervisory signaling. These unbalances have been investigated in detail and the results published in a technical report. Party-line unbalance due to the ringer ground is usually the controlling unbalance, so that coordination difficulties between telephone exchange systems and power distribution systems usually involve the party-line circuits before individual line circuits are affected.

The coupling between power and telephone circuits for a given degree of proximity depends upon the balance of the two classes of circuits to each other and ground. Advance has been made in methods for predetermining the coupling in new cases of exposure and for reducing the coupling in given situations of proximity. Extensive studies have been made of coupling of power-distribution circuits and telephone-exchange cable circuits using the same pole lines; the results have been published in technical reports. Much work has been done also on the coupling of open-wire telephone circuits both with power-distribution and power-transmission circuits; the results will be published as soon as they have been prepared in suitable form.

Coordinated transpositions of open-wire power and telephone circuits are a powerful tool for controlling this coupling. Available information is inadequate, however, as to the effectiveness of transposition in situations where important line irregularities occur which it is not possible to take into account in the transposition design. The subcommittee is investigating this problem.

Many of the existing noise-frequency induction problems have arisen because of the development of the art of the two industries without such close cooperation between them as now exists. From the work of this joint subcommittee it is becoming evident that while it is not practicable to design machinery and apparatus for power systems to be entirely free of harmonics, or to ideally balance either power or telephone circuits, it is possible to control these factors within limits which, in conjunction with the control of coupling obtainable by cooperative planning of routes and coordination of transpositions, permit satisfactory operation of both services without unduly burdening either.

A bibliography listing seventeen of the more important writings on this subject which have come to the attention of the authors is given as part of the winter convention of which the foregoing is an abstract.

Interference in Ocean Cable Telegraphy

The character of interference which may be present near the ends of submarine telegraph cables depends upon many local factors and can be determined only by actual field measurements. Relations between this interference and cable operation are discussed.

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PERFORMANCE of many submarine telegraph cables is affected by extraneous electrical interference. Often the message capacity is definitely limited by this factor. Consequently, it is desirable that the relations between interference and the performance of cables be studied and methods for measuring interference be developed and standardized.

The most common interference is of natural origin—from the same sources which cause the atmospheric disturbances or static which affect radio systems. Sometimes there is also interference caused by other cables or by electric railway or power systems. The amount of interference due to natural causes varies widely in different cables, being affected by the depth of the cable, the design of the core and the sheathing, the nature of the sea bottom, and other conditions. In general, the amount can be predicted only from measurements made in the vicinity.

Influence of interference upon the operation of cables is first discussed under the assumption that the interference is sinusoidal; this is then extended to include the actual interference which is quite irregular in form. Since the computations with non-sinusoidal interference are too tedious for general field use, an experimental method of measurement is given which may be used directly in determinations of the effects upon cable operation.

Interference and Cable Performance

If alternating current is transmitted into a cable and sinusoidal interference of approximately the same frequency is present at the opposite end, the relative

From "Submarine Cable Telegraphy: Influence of Interference," (No. 31-8) presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1930.

deflections of the receiving instrument due to these two sources may be computed readily from the known characteristics of the cable. The deflections due to sinusoidal interference of other frequencies and to various combinations of telegraph characters received through the cable also may be computed; but for this purpose it is necessary to know the manner in which the receiving equipment responds to sine-wave voltages of various frequencies. Such a frequency characteristic may be computed from theory or determined experimentally. For satisfactory operation it appears necessary that the deflection due to telegraphic characters should be at least five times the deflection caused by interference. Ordinarily the interference in a cable is not sinusoidal. An example of its irregular form is given in Fig. 1.

Knowing the frequency characteristic of the equipment, it is practicable to determine its response to various simple forms of transient induced voltage such as might be caused by interference. The computation is straightforward and involves a single, definite integration ("Submarine Cable Telegraphy," A. I. E E. Trans., 1922, p. 200); a number of examples have been worked out. It is also possible to compute the effect on signal reception of actual interference such as shown in Fig. 1; however, in that case the computations are too tedious for use in general studies of interference. Such computations are made unnecessary by the experimental method of investigation about to be described.

Fig. 1. Record of cable interference obtained using distortionless amplifier

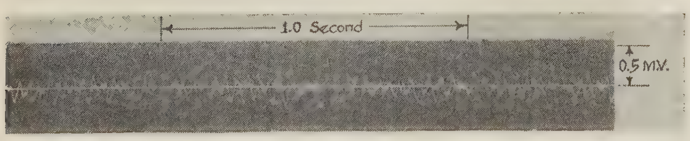

Fig. 2. Record of cable interference with amplifier tuned to 30 cycles per second; decrement = 0.8

Field Measurements

Obviously the most accurate method for determining the practical effect of interference would be to obtain records using receiving equipment which is adjusted to give properly shaped signals on the given cable. This method is not always convenient and has certain other objections.

An examination of the frequency characteristic of efficient receiving equipment indicates that it is somewhat similar in general form to that of a simple electrically-tuned circuit, and the method therefore suggests itself of making use of such tuning while the field records are being obtained. Since the quantity to be measured is highly erratic in amount such a method has been found to be sufficiently accurate for the purpose. The frequency of the tuned circuit must correspond to that frequency at which the cable equipment is most sensitive, and the broadness of tuning should approximate that of the equipment.

A convenient arrangement of apparatus for the purpose is an oscillograph connected to the output of a vacuum-tube amplifier, the latter having a symmetrically-tuned circuit between two of the stages and being otherwise distortionless. The tuning may be provided by means of a low-loss inductor and condenser and resistor in parallel, this combination constituting the external-plate load of the preceding tube. The resistor controls the broadness of tuning, the broadness being conveniently specified by stating its logarithmic decrement. The highest peak on the oscillogram is recorded as the amount of interference under the given conditions.

A sample record obtained with such equipment is shown in Fig. 2; an example of the manner in which the peak interference varies with the tuning frequency is given in Fig. 3. The measured interference also varies with the decrement and with the length of the record. The resulting effects on cable behavior may be determined with the aid of the above discussion on the influence of sinusoidal interference.

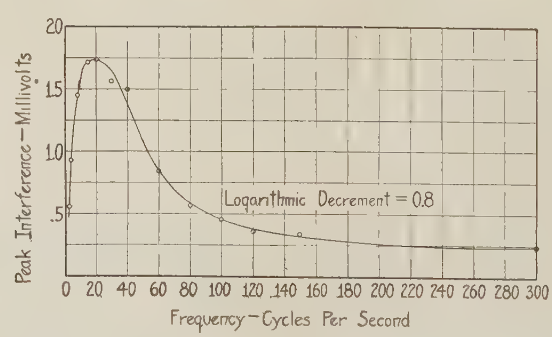

Fig. 3. Variation of peak interference with frequency of tuned circuit

Impulse Response Curves

By means of a simple experiment it is possible to determine directly what may be termed an impulse characteristic of the receiving equipment associated with a cable. This characteristic as here used is defined as the transient response of the receiving instrument, when an instantaneous or pure impulse of voltage is impressed in series (across a small resistor) in between the cable and its receiving equipment. It is interesting

to note that when the other is known either the frequency characteristic or the impulse characteristic may be computed by means of an integration. In order to determine the impulse characteristic experimentally, a charged condenser of proper size may be discharged across the resistor. An examination of such a characteristic yields valuable information as to the approximate frequency at which the equipment is tuned, and also gives an indication as to the sharpness of tuning and the sensitiveness.

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Transforming Reactor Improves D-C. Arc Welding

Transients normally prone to occur in a welding generator are eliminated by compensating action of a simple device external to the generator; desirable external reactance also is provided for a welding circuit.

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ARC WELDING, particularly when applied to ferrous metals has developed during the last decade into an art of great importance in industry. As this art progressed, the requirements for a proper power supply has been studied with the view of obtaining uniform and great strength of welds as well as ease in welding. To meet this demand, a motor-generator set has been developed and in addition, an auxiliary device of inductive character to aid the generator in producing ideal welding conditions.

Requirements for the generator may be stated briefly as follows:

1. The open-circuit voltage was chosen to range from 70 to 90 volts because experiments had shown that it is desirable to have this voltage above 70. With less voltage available, the arc has a tendency to break as it is elongated by unsteady welding or by the blowing from influences of external magnetic fields. This voltage is required also to break through scale on the iron. Tests have shown also that there is no advantage derived from a voltage higher than 80, although a margin of 10 volts above this to compensate for the voltage drop in long leads is advantageous.

2. The arc voltage runs from 14 to 25 depending upon the strength of the welding current. Thus it is required that the voltage of the generator should drop inherently from an open-circuit voltage of 70 or 80 to an arc voltage of 14 to 25. Regulation of the generator, as shown in Fig. 1, gives approximately a straight-line relation between voltage and current.

From "A New System for D-C. Arc Welding," (No. 31-19) presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1931.

As illustrated in Fig. 2, the generator principle involved is that of a dual magnetic circuit. The armature is wound for two poles and the field contains four poles; in general, the armature should be wound for half the number of poles contained in the field. In d-c. machines of standard design adjacent poles have opposite polarity, but in this machine the poles are paired in groups of the same polarity (a group of two north poles followed by a group of two south poles).

To establish a working theory, assume that the flux distribution is as in Fig. 2. There exist two fluxes ϕ_m and ϕ_c displaced 90 electrical deg. from each other. The flux ϕ_m will be designated the main flux, and the flux ϕ_c, the cross-flux.

Load current of the armature is taken from the two brushes, *A* and *B*, placed at neutral points between poles of opposite polarity. In addition there is an exciting brush, *E*. This machine is self-excited, the excitation being taken from brushes *A* and *E* in Fig. 2. The main magnetic circuit is so designed that magnetic saturation exists, whereas the cross-magnetic circuit is designed without saturation. As soon as the armature is loaded there is set up an armature reaction *R*, which may be resolved into two components *R M* in the direction of the main flux and *R C* in opposition to the cross-flux. Since the main magnetic circuit is saturated, component *R M* cannot force any more flux through this circuit and the main flux remains practically constant. Component *R C*, however, blows out the cross-flux which thus decreases as the load increases. Machine voltage *A B* is the algebraic sum of *A E* and *E B*. Voltage *A E* is induced by the main flux and remains practically constant since the main flux and the speed are constant. Voltage *E B*, however, decreases with the load since the cross-flux decreases as

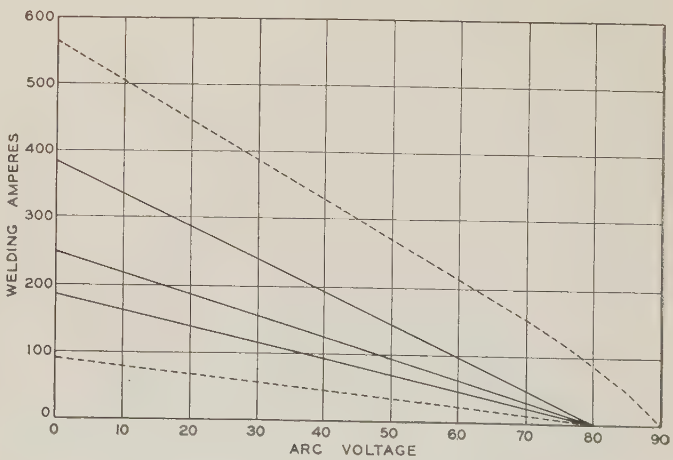

Fig. 1. Generator characteristics

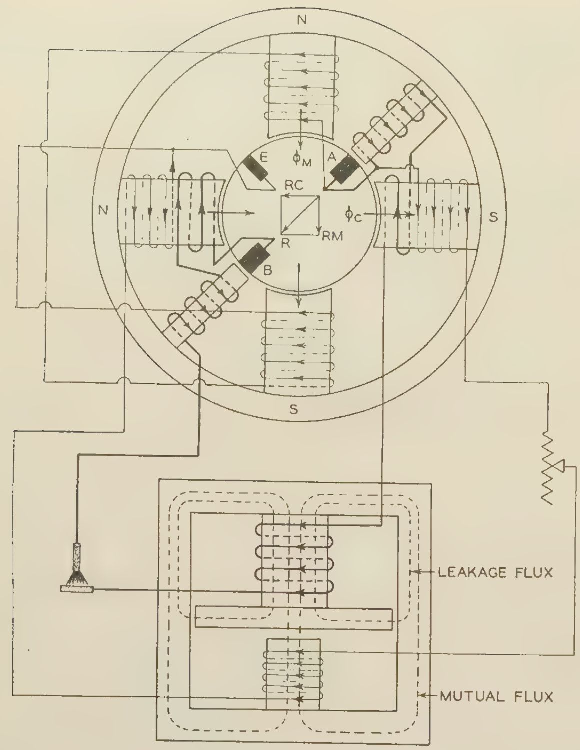

Fig. 2. Schematic diagram showing principles of generator and method of connecting transforming reactor

described. As a matter of fact, the cross-flux passes through zero and is finally reversed.

If it is desired to weld with smaller currents, a series winding is placed on the cross-poles supporting the armature reaction. It being desirable to obtain different welding currents, the series winding is provided with taps; and to secure close adjustment of the welding current a field rheostat is inserted in the cross-circuit. To obtain good commutation, commutating poles are added.

This design results in a set of welding currents as shown in Fig. 1 which particular curves apply to a machine rated at 300 amperes and capable of delivering a minimum of 75 amperes, and a maximum of 450 amperes.

In actual welding the current is never constant because the circuit frequently is short-circuited by small globules of metal and because the electrode is not fed at exactly the proper rate, particularly in hand welding. Under such conditions, transient currents and potentials appear in the generator and the regulation deviates from the curves shown in Fig. 1, which correspond to static conditions. In striking the arc, the current overshoots its steady value, and in breaking the arc a certain time interval is required for the voltage to return to its normal open-circuit value. It is desirable that the short-circuited current should not be excessive, and it is also desirable to have the voltage build up rapidly.

To cope with these transient conditions, a special inductive device which may be called a transforming reactor was developed. (Fig. 2) The primary winding of this device is connected in series with the arc, and its secondary winding in series with the shunt field of the cross-magnetic circuit. These two windings are connected in such a way that the direct current flowing through them will magnetize in the same direction.

The function of the transforming reactor is to provide external to the generator a magnetic coupling between the arc circuit and the field circuit, which coupling will be opposite in effect to that between the two circuits within the generator. Suppose that the arc is suddenly broken; then the ampere-turns of the arc circuit (both in the generator and in the transforming reactor) suddenly disappear and since the secondary winding attempts to maintain the mutual flux, the secondary current has a tendency to increase and counteract the tendency of the generator magnetic circuit to make it decrease. Thus the transforming reactor tends to keep the cross-shunt field current constant regardless of changes in the arc-current. The result of this is to make the voltage build up more rapidly to its normal value when the arc is broken, and to limit the peak value of current when a short-circuit is made.

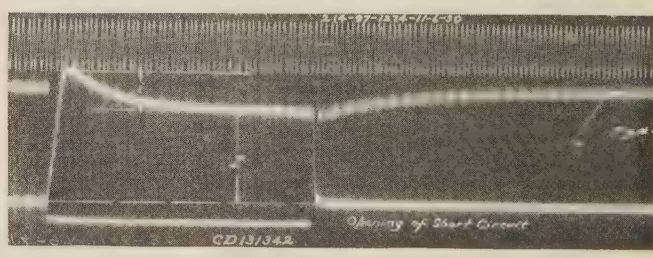

Fig. 3. Oscillographic record of action of combination of Fig. 2 under conditions of suddenly-applied and suddenly-relieved short circuit

To illustrate the principle of this generator in conjunction with the transforming reactor an oscillogram is shown in Fig. 3, showing what happens when the arc is short-circuited and the short circuit immediately thereupon opened is given in Fig. 3. The steady value of the short-circuited current is I, and the transient value i is quite small. When the short circuit is removed, it may be noted that the generator voltage builds up to the open-circuit voltage, V, almost instantaneously.

This oscillogram proves that the transforming reactor fulfills its purpose in practically eliminating the transients, making the generator, during sudden changes of arc current, follow the regulation curves obtained under steady conditions.

To function ideally, this device should be designed in such a manner that the mutual induction between its

two windings is the same as the mutual induction existing between the cross-magnetic shunt winding and the armature winding with its series winding.

Let N_1 = total effective number of turns on the cross-axis of the generator carrying the welding current.
N_2 = total number of cross-shunt field turns.
n_1 = number of turns on the transforming reactor carrying the welding current.
n_2 = number of turns on the transforming reactor in series with the cross-shunt field.
F = cross-flux per ampere-turn of the generator
f = mutual flux per ampere-turn of the reactor.

The design of the transforming reactor should then satisfy:

$$f \times n_1 \times n_2 = -K \times F \times N_1 \times N_2$$

The minus sign is used, since the two windings on the transforming reactor support each other, whereas in the generator corresponding windings oppose each other. In order to eliminate all transients, K should be equal to 1; however, fractional values of K give very good transient performance.

Experience has shown that to stabilize the arc, a certain amount of series reactance in addition to generator reactance is necessary in the arc circuit. This additional reactance is supplied by shaping the magnetic circuit of the inductive device so as to enlarge its primary leakage. (Fig. 2) Thus the transforming reactor has two fluxes; namely, the mutual flux which links both the primary and the secondary windings, and the primary leakage flux interlinked with the primary alone.

Experiments have shown that this combination welds with great ease both for hand and automatic welding. It lays down the metal with ease and accuracy under all conditions met in welding, and produces welds of uniformity and strength.

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Electricity in Modern Dairy Plants

With the advent of the Electropure method of pasteurizing, in which electric current is actually passed through the milk, the modern dairy is taking its place among the important users of electricity. Other uses of electricity in such plants are also described.

By A. J. Dreux and *H. C. Brunner*

Non-member — Rieck-McJunkin Dairy Co. Pittsburgh

Associate A. I. E. E. — Westinghouse Elec. & Mfg. Co. East Pittsburgh

MODERN electrified dairies such as the main plant of the Rieck-McJunkin Dairy Company in Pittsburgh should be of particular interest to electrical engineers especially since the power survey recently made in that plant on the question of purchased power *vs.* gas and steam-engine generation. The desirability of the electric load for such a modern dairy plant is indicated by the fact that under the proposed operation, the average monthly power consumption would be 242,965 kw-hr. at 94.2 per cent power factor. The load demand is quite uniform throughout the year as indicated by the fact that the greatest maximum monthly demand is 962 kva. and the average maximum demand is 887 kva.

Under the proposed operation, all d-c. motors with the exception of those operating elevators would be replaced with three-phase, 60-cycle, 220-volt motors. Existing steam- and gas-engine-driven generators would be shut down and the present total electrical requirements purchased from the Duquesne Light Company, by whose power and steam survey division the study was conducted. Data and comparisons presented in this report indicate an annual saving of approximately $7,500 in favor of purchased power over present steam and gas-engine operation in which the annual power-plant operating charges are approximately $175,000. This saving is due principally to reductions in coal, labor, gas, and repairs.

Under present operation, the 680-ton capacity of refrigerating machines, and most of the power-plant auxiliary equipment, is steam-driven, and no immediate change in this arrangement is being considered by the dairy. The power survey therefore did not include a study of advantages obtainable by the electrification of this part of the plant although a few brief comments on the subject are included in this article.

Plants such as the Rieck-McJunkin main plant will average about fourteen receiving stations where the milk is cooled and fed to large heat-insulated tank trucks. The electric motors installed in each of these stations will total from 25 to 75 hp., depending upon whether or not the station also has milk-condensing equipment, butter churns, or ice cream equipment.

Upon arrival at the main plant, the milk (after recooling) is fed by gravity into the pasteurizing room, (Fig. 1) and collects in two small constant-level tanks equipped with float valves. The equipment shown in Fig. 1 occupies floor space of 18 by 30 ft. with a maximum height of 10 ft., and consists of six Electropure

From "A Modern Electrified Dairy Plant," (No. 31-58) presented at the Middle Eastern District meeting of the A. I. E. E., Pittsburgh, Pa., March 11-13, 1931.

units which pasteurize and cool to bottling temperature (40 deg. fahr.) 13,200 qt. of milk per hour.

In the Electropure process, pasteurization is accom-

Fig. 1. A pasteurizing room equipped with six 2,200-qt. per-hr. Electropure process units

plished by an electrical-conductivity method by actually passing electric current through the milk. The heat of pasteurization is generated within the body of the milk itself during the time the milk is being pumped through a rectangular chamber, the ends of which are formed by two carbon electrodes. These electrodes are connected to the conventional 220-volt power supply and for a 2,200-qt.-per-hr. unit, they are 32 inches long and four inches wide; they are spaced three inches apart. Such a unit consumes 48 kw. per hour.

Electrical resistance offered by the milk to the flow of the electric current causes the temperature of the milk in the electrode chamber to be raised quickly. If either this electrical resistance of the milk or the power-supply voltage changes, the amount of heat generated within the chamber will change. In actual operation both are varying continually, and some means must be provided for regulating accurately the rate of milk flow to compensate for these, and to maintain a practically constant temperature at the outlet of the chamber. In addition, it is necessary to compensate for changes in the temperature of the raw milk supply. Limits of the practical operating range are set at the low-temperature limit by health codes, and at the upper limit, by the critical eye of the housewife. If the temperature drops too low, pasteurization will be incomplete; if the temperature rises too high, the amount of cream showing in the top of the milk bottle will be decreased.

On the six units shown in Fig. 1 the electrode chamber outlet temperature is regulated by means of a hand-operated micrometer valve and a controller which provides three speeds for the milk-circulating pump. The units in Fig. 2 are equipped with recently-developed supervised automatic control. This supervised automatic control was developed by Westinghouse to simplify the operation of the process, eliminate the possibility of human errors, secure an accuracy of temperature control not dependent upon the skill of the

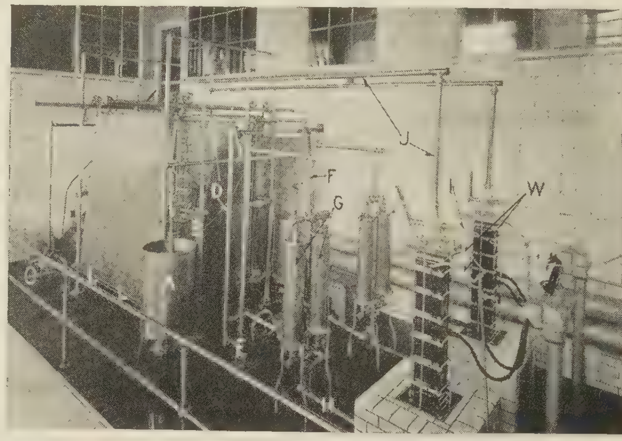


Fig. 2. Recent Electropure process installation equipped with supervised automatic control

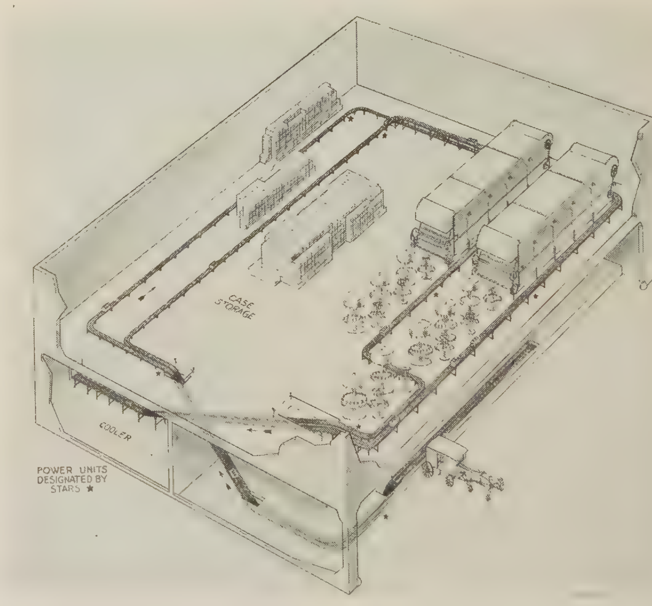


Fig. 3. An automatic case conveyer driven by eleven 2-hp. motors, conveys the returned empty cases to the bottling department and then to the cooling room

operator, and make unnecessary constant attention by an attendant.

Should some abnormal condition cause undertreated milk to be circulated in the units equipped with these recently-developed controls, the control automatically stops the circulating motor and indicates to the operator

what has occurred so that he may make the adjustment necessary to return the system to normal operation. This means that the operator may spend practically all of his time on other work; and since the control is accomplished entirely by adjustments in the electrical circuits, the control station may be located in a laboratory or any other room adjacent to the pasteurizing room.

In the Rieck-McJunkin plant, the cooled milk flows from the Electropure units to the bottle fillers by gravity, an automatic chain-conveyer system feeding fresh, clean bottles to and from the fillers (Fig. 3). This conveyer system is driven by eleven 2-hp. squirrel-cage electric motors, and its installation enabled the dairy to handle the same amount of milk in two hours less time with eight less men and two less bottle fillers.

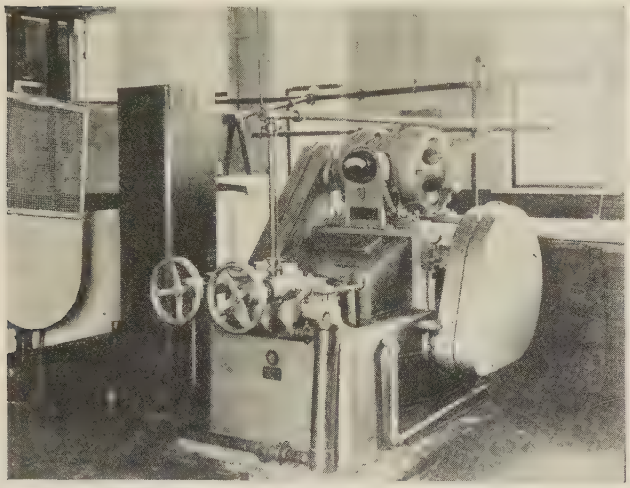


Fig. 4. An ice cream homogenizer which in reality is a special form of high-pressure pump. It is equipped with an ammeter to indicate the operating pressure

Fig. 5. Drawrite freezer meters and controls for regulation of the ice cream freezing process

The other milk products are obtained by similar careful processes, the details of which will not be given here. A few illustrations of the more important machines are presented, however, and their power requirements and load characteristics mentioned so as to give a more complete picture of the electrical apparatus.

The homogenizer (Fig. 4) is in reality a high-pressure pump which, depending upon its size, will require a motor of from 15 to 40 hp. By forcing the ice cream mixture through a specially designed orifice, this machine produces ice cream of even and fine texture.

In the freezing of ice cream, electric meters (Fig. 5) are used to record the freezing action. As the mixture freezes, the motor load increases; when the cream is properly frozen, the refrigeration valve is closed. The freezing is stopped, but the mixing continues until the whipping action has incorporated the correct amount of air to give the desired light, creamy appearance. This is known as the "over-run," and since the motor load decreases during this period the correct amount of whipping is also indicated by the meter.

Electrically-driven delivery trucks are frequently used by some of the large dairy plants, particularly those in cities where the routes are level and few hills are encountered. The ease of controlling the truck from either side, and the absence of gas fumes, make this type of truck especially desirable. Two 200-kw. motor-generators with a panel board (Fig. 6) are used for charging the batteries of trucks operating from a large Chicago dairy of approximately the same size as the Rieck-McJunkin plant.

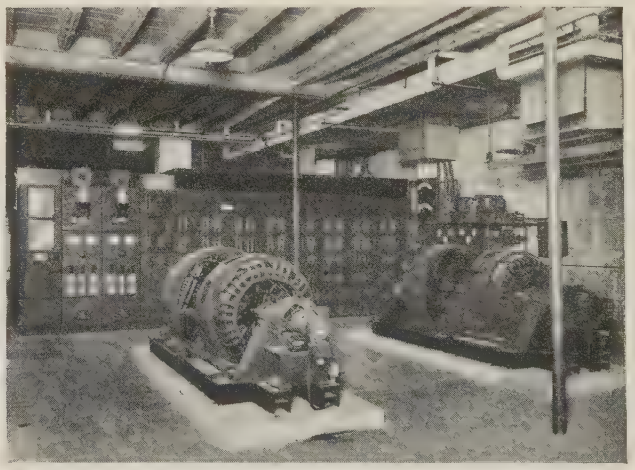


Fig. 6. Two 200-kw. battery-charging motor-generator sets and switchboard installed at the Borden dairy plant in Chicago for charging the batteries of electric milk-delivery trucks

Cracking Oil by Electricity

Low-grade oils formerly wasted now are "cracked" to form gasolines and other highly volatile oils. Some of the problems encountered in developing a reliable electrical process for accomplishing this are discussed in this article.

By Herbert R. Rowland

Member, A. I. E. E.

Moody Engineering Company, New York

FOR MANY YEARS, in this country and abroad, attempts have been made to use either silent corona discharge or the electric arc for the breaking up of heavier groups of hydrocarbons into lighter groups. It now is practical to manufacture gasoline by the corona method, the resulting product being a high-grade motor fuel.

In the cracking operation, heat must of necessity be supplied. When the electric arc is used heat is naturally furnished by the arc but is so intense that undesirable elements are formed which cannot be removed except at considerable loss and expense. When the corona method is used the amount of heat dissipated is too small to carry on the cracking operations and therefore heat must be supplied from some other source.

Probably the most consistent operations in electrical cracking have been carried on during the past thirteen years in Kansas City. This work was started using coronas produced by means of high-frequency circuits, but for many years insufficient gasoline was produced to prove the industrial or commercial worth of the process. This was due to two major causes; namely, the frequent breakdown of insulators resulting from the high temperatures used for vapor-phase cracking (900 to 1,150 deg. fahr.) and the extremely high power consumption which was due to losses in the attendant high-frequency apparatus, the over-all electrical efficiency of which was less than 0.5 per cent.

At this point in the development about seven years ago the writer was assigned the task of carrying on this work. At the outset it appeared both useless and unnecessary to continue with the costly and inefficient high-frequency method for producing the silent corona discharge.

The bibliography of the matter seemed to show quite conclusively that the voltage required for corona formation and silent discharge was governed mainly by (1) the size and composition of the wires or surfaces between which this silent discharge takes place, (2) the distance separating these two surfaces, and (3) the vapor tension of the enclosed medium.

Before making any major change in the characteristics of the electric circuit then in use, the writer consulted with the late Dr. C. P. Steinmetz, to whom he wishes to give full credit for the ideas, encouragement, and assistance he received from this conference. Early it was seen that the major part of the problem was concerned with voltage and insulation. Voltage required for silent corona discharge was found to be dependent upon both the size and composition of the wires or surfaces on which the phenomenon was to take place.

Steel, copper, nichrome, tungsten, and metal combinations, all have their different corona voltage characteristics. Other conditions being satisfied, metallic tungsten wire probably produces corona at a lower voltage for a given diameter than any other metal. However, due to its liability to oxidize when heated in an atmosphere containing even a small amount of air it was not suited for this work.

Nichrome-steel wire due to its extremely high elastic strength and its resistance to oxidation when heated in the presence of air was adjudged the most suitable metal.

The other side of the electric circuit consisted of the inside of a 12-in. pipe, it being necessary to handle in a completely enclosed system highly superheated volatile and explosive gases, such as vaporized oils.

The corona wire must be axially in the direct center of the reaction tube. Therefore it must be centered at the top of the tube by some type of insulator and at the bottom of the tube by another insulator which would hang as a weight on the wire, keep it axially taut in the tube, and prevent movement which might be caused by the flow of the vapors in the tube. A weight of ¾ lb. was found to be sufficient to keep the wire taut. It was finally found that No. 26 B&S gage was the smallest nichrome-steel wire that would support the ¾-lb. weight without stretching when heated to a temperature of 1,300 deg. fahr. This size and type of wire was therefore selected as possessing the best obtainable combination of the mechanical and electrical properties required for this work.

The next problem consisted of the selection of a suitable insulator; with proper allowances for safety factor an insulator for this work must meet the following severe requirements:

1. Operate continuously at 37.5 kv., 60 cycles without puncture.
2. Withstand a 45-kv. flashover.
3. Must be made of smooth material and built without petticoats so as not to have lodging places for local deposits.
4. Must not change shape or form at temperatures as high as 1,350 deg. fahr.
5. Must withstand this temperature on the bottom half, the upper half being at room temperature, without cracking.
6. Must have sufficient mechanical strength to prevent crushing when fastened securely in a stuffing box against hot vapor pressure.

From a paper informally presented before the A. I. E. E. Kansas City Section, April 22, 1930.

A study was made of the various materials from which an insulator of the foregoing requirements could be safely and economically manufactured. Glass, lava, and porcelain were tried, but it was found that these substances punctured at temperatures only slightly higher than the boiling point of water. These substances had a further extremely bad fault in that the part protruding from the reaction tube and projecting into the air, cracked and broke off when the part remaining in the tube was heated.

As a last resort fused quartz was tested and while the puncture temperature was only about twice that of other materials, the outer end of the quartz tube would not crack and break off when the enclosed part was heated to a high temperature. As long as the quartz was mechanically sound it was thought that if the insulator were made large enough it would act as a filler for an air-gap distance which would itself be of sufficient width to prevent a discharge between electrodes.

Accordingly many runs were made on enlarged insulators and while some of them operated satisfactorily for nearly 100 hr., others would puncture in less than 8 hr.

In order to separate the two electrodes still further the next step was to set the quartz insulator in a disk about 8 in. in diameter and one inch thick. While a combination of the tube and disk prevented puncture, in order to prevent leakage of the vapors past the disk it had to be placed in a stuffing box. Here it was found that quartz when heated and held firmly in one dimension would give no trouble from thermal expansion, but if confined in more than one dimension would shatter when heated. After several of these disks had broken, resulting in serious fires, this idea was abandoned.

Continued investigation led finally to the adoption of an oil-cooled insulator as shown in the accompanying illustration. As may be seen, this insulator consists of a tube of clear quartz of sufficient length to prevent flashover, enclosed over a part of its length in an envelope made from a larger diameter of quartz tubing. This outer envelope is fused to the inner tube at the bottom, the top being left open. Cooling oil is circulated in the annular space between the inner and outer tubes. An annular rubber cork is inserted in this space at the top of the outer tube through which two metal tubes sealed with a special cement extend into the cooling chamber.

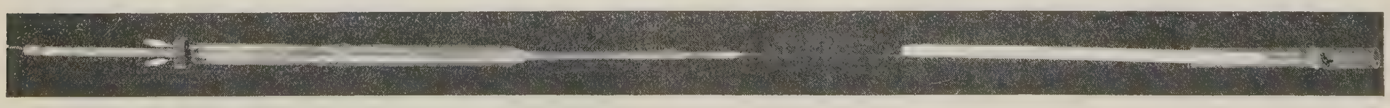
The outer ends of the tubes carry threads that will fit a 1/8-in. pipe-thread union. To these are connected well annealed copper tubing through which the cooling oil is led to and from the insulator. To prevent possible short-circuiting or electrical rupture on account of the metal tubes, a long piece of bakelite tubing is installed in each tube circuit which effectively breaks their electric continuity.

The central electrode runs down through the inner quartz tube, this electrode being made of flexible copper wire and brazed to the corona wire; this in turn is fused into the quartz, thus making a vapor-tight joint.

An insulator for use at the bottom of the reaction tube presented a much simpler problem, it was necessary only to provide sufficient weight to keep the wire taut and enough length to prevent flashover. This insulator has been made in two parts; a strip of metal containing a proper sized hole is first welded on the inside of the reaction tube so as to bring the hole directly in the center of the tube; into this hole is slipped a quartz thimble. Fastened to the corona wire is a quartz tube approximately 18 in. long, loaded with quartz sand until it weighs exactly 3/4 lb. This tube is slipped through and hangs loosely inside of the thimble. The combination of tube and thimble gives great flexibility, combines a long flashover length with a small air-gap, and in case of any variation in the thermal expansion of either the reaction tube or the wire permits automatic adjustment. This combination has given no trouble except in those cases where the corona wire broke.

Apparatus for supplying high voltage is extremely simple; a 33-kv. step-up transformer is used connected on the low-voltage side directly to 220-volt, 60-cycle mains. This transformer contains sufficient built-in reactance so that in case of a short circuit on the high-voltage side there would be no abnormal rush of current. One high-potential lead is connected through disconnect switches to corona wires in the various reaction tube insulators, the other lead being connected directly to the reaction tubes and solidly grounded. A voltmeter connected across the primary terminals of the transformer, which ordinarily reads the impressed e. m. f. will read zero thus giving an indication of trouble in case of a punctured insulator or when a broken corona wire touches the surface of the reaction tube.

It is not thoroughly understood just what part this



Cooling tubes Main insulator Corona wire Bottom bob Bottom thimble

Insulators for oil cracking by the silent corona discharge method. In service the assembly normally hangs suspended from the left-hand end as shown here

silent corona discharge plays in the cracking process; however, three theories have been advanced as follows:

1. More perfect ionization of the vapors is produced by the corona discharge and therefore a more complete cracking takes place. This is known as the electrothermal theory.

2. Corona discharge sets up an agitation of the vapors and a possible electronic bombardment of oil atoms against the hot walls of the cracking tube, thus insuring a more perfect heat cracking. This is called the electromechanical theory.

3. The electroprecipitation theory, according to which gasoline is precipitated by the corona from the other vapors in the tubes, thus causing a clearer separation of the gasolines from the uncracked oils.

Since the amount of power used for five tubes handling a total of ten barrels of oil per hr. at a power factor of not more than 10 per cent is less than one kilowatt, this appears too small to accomplish a great deal of ionization. In the case of the electroprecipitation theory it seems impossible to precipitate a vapor from a vapor, since in these tubes at the temperature maintained all of the oil passing through must be in vapor form.

On the other hand it seems entirely feasible, to consider an electron moving through an appreciable distance in space and either carrying with it or driving before it a molecule of hydrocarbon in the vapor form. At last a surface is reached which permits no further movement of the oil vapor molecule, but which readily absorbs the electron. The impact of this molecule can be very great and the pressure at impact can run into large amounts, thus causing cracking by both pressure and heat when the force is expended against the hot wall of the reaction tube. It therefore seems that the violent agitation of the vapors by the silent corona discharge is undoubtedly of prime importance in the complete cracking of the vapors. These facts would tend to support the electromechanical theory.

The gasoline produced by this process constitutes in itself, without blending the saturate, unsaturate, and aromatic groups, a fuel that has not only high antiknock value but also more miles per gallon than "doped" fuels.

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Field Test on Thyrite Arresters

A study of the performance of Thyrite lightning arresters when subjected to artificial lightning discharges of 1,500,000 volts has been made. The results obtained under different operating conditions are discussed in some detail.

By K. B. McEachron and E. J. Wade

Member A. I. E. E. Associate A. I. E. E.

General Electric Company
Pittsfield, Mass.

STUDIES with natural lightning determine the form of waves which may appear in service, while artificial lightning (since it can be repeated at will and studied completely) is best used to disclose the performance of lines and apparatus.

During the last two years, investigations have been made in cooperation with the Consumers Power Company on their S-19 line which is about 45 mi. long. Various subjects were studied but this paper deals only with the tests made on lightning arresters during the summer of 1930.

A portable cathode ray oscillograph was especially designed for this work by one of the authors (E. J. Wade). It is of the cold-cathode type and incorporates many features making for rapid and reliable operation.

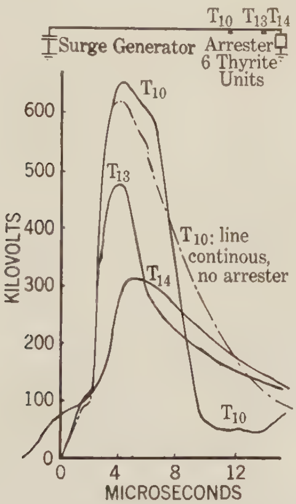
The impulse generator was located at the end of the line and consisted of 60 banks of oil capacitors, each of 0.5 μf., and charged in parallel to 25 kv. The open-circuit voltage when discharged in series was 1,500,000

1,500,000-volt impulse generator connected to line

From "Field Tests on Thyrite Lightning Arresters," (**No. 31-11**) presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1931.

volts. The lightning arresters being studied were located 1.5 mi. away from the impulse generator. This distance was chosen as being far enough to give true traveling-wave conditions but not far enough for the waves to be reduced too much by attenuation.

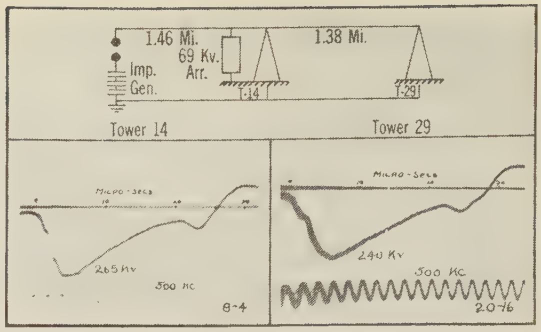
Methods of calculating the performance of the Thyrite arrester under any assumed condition have been developed and the first tests were made to check these calculations for ratings up to 220 kv. under three line conditions; *i. e.*, line continuous, line open, and two lines in parallel. These correspond respectively to the arrester being located at a point on a line, at the end of a single line, and connected to a bus with two outgoing lines. The agreement between the test results and calculated values is very good. It was found justifiable to add the ground resistance in calculating the arrester performance. If the arrester and apparatus grounds are bussed together the protection will be independent of ground resistance.



Impulse wave-shape at points between generator and arrester. Note that protection does not extend far beyond the arrester

The effect of a flashover on the line before the wave reaches the arrester is an interesting condition which is met with very frequently in practise. Tests were made to show what happens both without any arrester and with a 69-kv. arrester located three spans beyond the flashover point, which consisted of five insulator disks. When the arrester was connected, the flashover was delayed two and one-half microseconds and the oscillations were effectively suppressed. The point of flashover was too far away to be protected by the arrester.

Another series of tests of great interest was the measurement of voltage at various distances from the arrester. It was found that arrester protection does not extend much beyond 500 ft. for the wave used. Even if the arrester had reduced the potential to zero the zone of protection would not have been appreciably extended. The wave shape at distances beyond the arrester is the same as at the arrester, being changed only by attenuation.



Impulse wave-shape at points beyond the arrester showing that attenuation is apparently the only influencing factor

The question of arrester location and length of connections is of fundamental importance, and a number of different arrangements was tried. These included the so-called "hair-pin" loop, connecting the arrester in one or two stacks, long arrester connections versus long transformer connections, and the effect of a capacitance to simulate station apparatus. All the results can be explained by giving proper consideration to the effect of circuit length. The effect of the arrangement and turns or bends in the circuit was shown to be negligible.

It is of primary importance to locate the arrester close to the apparatus to be protected but if it must be at a distance, it is better to have long transformer connections rather than long arrester connections. This is because with long arrester connections the transformer reflects the incoming wave, while with short arrester connections, the transformer reflects only the arrester potential. The excess voltage which may be introduced by a certain length of connection does not depend upon the arrester rating; however while a given increase in potential may be considered negligible on a high-voltage arrester protection offered by a low-voltage arrester may be insufficient.

This investigation shows that Thyrite arrester performance for any given impulse wave can be closely calculated if the length of the connections and the ground resistance are known. Several hundred oscillograms have been taken, making available much valuable information regarding the application of lightning arresters.

These tests are part of a large program of transient investigation conducted jointly by the Consumers Power Company and the General Electric Company. The field work was in charge of E. J. Wade and J. R. Eaton, who were assisted by Messrs. W. J. Rudge, O. Brune, C. C. Tanner, E. J. Shimek, D. Blackwell and others.

Vertical A-C. Distribution Networks

With buildings from 500 to 1,000 ft. in height becoming common in large cities, load densities have increased to many times their former values. Vertical low-voltage networks supplied from transformers located on different floors of these high buildings, are well suited to cope with such extreme concentrations of load.

By A. H. Kehoe *and* *Bassett Jones*

Fellow A. I. E. E. — Member A. I. E. E.

United Elec. Lt. & Pwr. Co. New York — Meyer, Strong, & Jones New York

VERTICAL NETWORK SERVICE was first offered by companies comprising the New York Edison System in December 1928, at which time the arrangement was accepted by the owners of the Irving Trust Company building at 1 Wall Street as suitable for the electric supply to that building. Similar arrangements were made almost simultaneously with several other large buildings which at that time either were being planned or were under construction. Since then, this type of service has been adopted for practically all new buildings in New York City, of more than forty stories, as well as for some lower structures. A few high buildings of the tower type having comparatively small floor areas have been built recently, but in these cases there is only a slight advantage in this specific service.

On January 1, 1931, there were in Manhattan ten completed buildings with vertical network service completely installed, comprising a total connected load of about 31,700 kw. Seven more buildings incorporating this service are now under construction. In these the total connected load will be about 14,300 kw. In addition, five new buildings are being planned with power and lighting requirements totaling about 30,000 kw., and in these it is expected to use the vertical network systems. The accompanying table gives detailed information regarding typical installations.

High-Voltage Supply Above the Street Level

For densely-loaded urban areas in many localities a-c. distribution in recent years has taken the form of multiple-feed networks. The first installation of this type in New York City was completed in 1922. This arrangement provides an economical and reliable system which satisfies the electrical distribution requirements of most urban districts. In many cases these networks are of the three-phase, four-wire type, and are operated at 120/208 volts. Distance from the distribution transformers over which energy at such voltages can be economically transmitted, however, is definitely limited if both a reasonable amount of copper for distribution and satisfactory regulation are to obtain.

In a number of cities there has been a decided tendency in recent years to increase the height of buildings; this has resulted in an increase of total floor area to many times the ground area, with a corresponding increase in the electrical density of distribution. While in these large buildings the electrical-load density per sq. ft. of floor area has increased somewhat, the percentage increase, of course, is much less than the increase in load density based on ground area.

While this load may be considered in the light of an extremely dense load at the street level, yet the area may be so located that it is cheaper in over-all costs to supply it from distribution transformers located in upper floors of the building than to supply the energy at 120/208 volts from the street distribution system. Thus it might be considered that the utility has been presented with the equivalent of a large addition to its territory. This will be understood readily when it is realized that building heights of from 500 to 1,000 ft. above the street now are becoming commonplace and such buildings require large banks of elevators, the motors of which are located in the upper stories of the building. Some of these elevators have motors ranging in size from 100 to 150 hp. for the higher buildings, with short period demands several times these values.

With such dense loads at an appreciable distance from the street level, it is found to be definitely economical in over-all costs to distribute with multiple high-voltage supplies feeding a low-voltage network throughout the building. This system is identical in principle to the street network system, as may be seen in the accompanying illustration.

Economic Aspects

Comparative estimates of building wiring costs for the Irving Trust Company Building mentioned previously, showed a saving of $35,000, for the vertical network system as compared with the system in which the service transformers are all located in the

From "Vertical Networks in Metropolitan Office Buildings," presented informally at the Middle Eastern District meeting of the A. I. E. E., Pittsburgh, Pa., March 11-13, 1931.

basement. However, some modifications in plans were made at the request of the local inspection authority and all of the above estimated saving was not realized.

In the Empire State Building the network system has been applied to the individual floors. Four-wire 120/208-volt feeders from one or more centers of distribution, where they are fused, feed into a four-wire main, circling each floor. Unfused branch circuits are tapped off this main to feed one or more "bays."

With the radial system of building wiring, enough copper must be run from the house switchboard to each load group (say three floors, for lighting, elevator bank, or other motor group) to carry the maximum load of that group. With the network system using a tie bus between transformer banks, the advantage of load diversity is realized in reducing the amount of copper required. The utilization factor can be worked out by the known probability factors for the case (see Power Calculations for Elevators by the Method of Probabilities, *G. E. Review*, October-November 1930). This method applies not only to elevators but is applicable also to variable loads of any kind for which an "operating factor" can be determined. The fifteen-minute demand (r. m. s. value of the load over this period) on the usual elevator bank is about thirty-five per cent of the connected load. With the old radial system of wiring a separate feeder, or duplicate feeders, having at least the load capacity of the fifteen-minute demand on each bank must be run to each such bank.

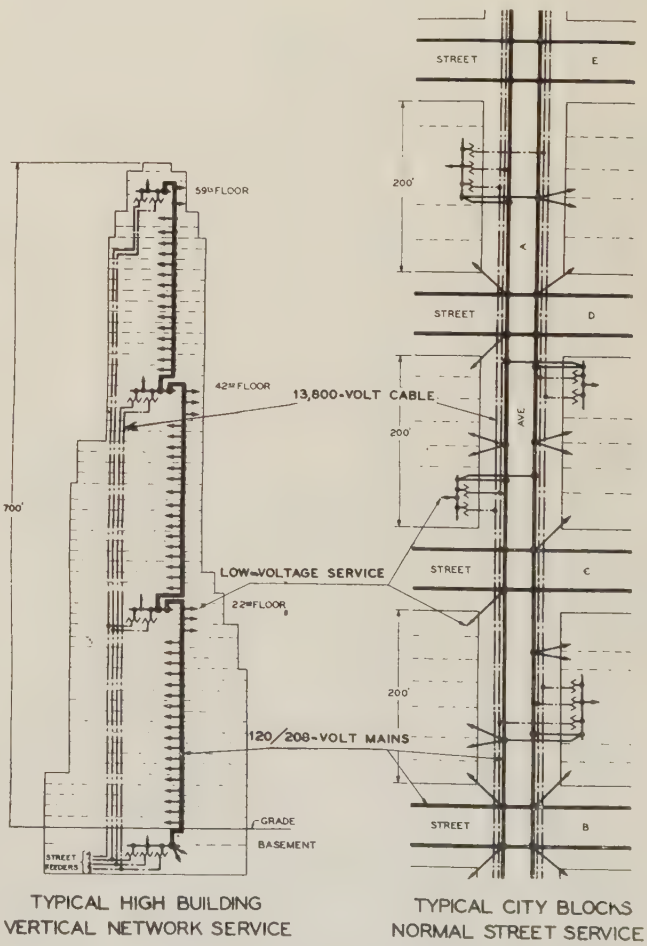
Ownership of Equipment

Since a distribution installation in a building cannot be considered as having the permanency of a street system, (it being subject to the whims of the building owners) and since it cannot be utilized for any service other than for that particular building, there is naturally a distinct limitation to the amount of investment that the utility company can make for such an installation. On the other hand, if the vertical distribution network is used instead of distributing throughout the building from street services the building owner realizes a definite saving in building wiring. It is thus reasonable to have a different division of expense for vertical distribution from that which would be used in the case of general distribution throughout a city.

The division used in New York is to have the utility company supply, and own and maintain the high-voltage cables and the distribution transformers with their associated network equipment. These are placed in position by, and at the expense of, the building owners in ducts and vaults supplied as part of the building installation. All low-voltage distribution conductors and ducts except the 120/208-volt a-c. network ties from the street mains to the first distribution point within the building are owned and installed by the building owners. While the building owners install the transformers and high-voltage cables, all connections are made by the utility company. In case the building is abandoned this division makes it possible for the utility company to recover all its equipment, and the costs incurred are not materially different from those in supplying the building directly from the street system. In the case of high buildings the cost of the wiring installation is considerably reduced. Certain expense, of course, is incurred in securing space for transformer vaults, but in most cases space yielding little of value can be used for this purpose.

Low-Voltage Tie Connections

If all conditions of supply for vertical distribution were the same as those found in the common network system, the installations would be unusual only from the standpoint of establishing the division of ownership and maintenance between the building owner and the utility. However, as the types of installations made to date will indicate there are numerous conditions which cause these services to differ. The vertical networks



Schematic diagrams of street and vertical distribution networks showing similarity between the two systems

TYPICAL VERTICAL AND HORIZONTAL NETWORK SERVICES

Name and type of building	Stories	Gross floor area (sq. ft.)	Total feeders supplying service 13.8 kv.	Total feeders supplying service 3 kv.	Vault location (floor)	No. of banks	Size of banks (kva.)	Initial capacity in vault (kva.)	Character of inter-vault ties	Terminal points of inter-vault ties	Sizes of inter-vault ties	Load and estimated demand	Status of installation
Chrysler (Office)	77 and Tower	1,160,000	5	3	Basement	4	300	1,200	Non-fused	St. N. W.-Base	7-4/0	Light =2,460 kw.	Complete
					30th	4	300	1,200	None	Base-30th	None	Power =3,378 hp.	Complete
					60th	4	150	600	None	30th-60th	None	Demand =2,500 kw.	Complete
					74th								Held pending flood light development)
Bank of Manhattan (Bank & Office)	72 and Tower	800,000	5		Basement	5	300	1,500	Non-fused	St. N. W.-Base	7-4/0	Light =3,241 kw.	Complete
					15th	5	150	750	None	Base-15th	None	Power =3,765 hp.	Complete
					65th	5	150	750	None	15th-65th	None	Demand =2,000 kw.	Complete
Daily News	36	723,500	4		Basement	4	150	600	Non-fused	St. N. W.-Base	2 (7-4/0)	Light =1,115 kw.	Complete
					25th	4	150	600	None	Base-25th	None	Power =1,292 hp. Demand = 900 kw.	Complete
(Office and Printing Plant)	9	314,090	5		Base	5	300	1,500	Non-fused	St. N. W.-Base	7-4/0	Light = 639 kw.	Complete
					2nd	4	300	1,200	Fused Non-tapped	Base-2nd	2(7-4/0)	Power =2,782 hp. Demand =1,500 kw.	Complete
Irving Trust Co. (Bank & Office)	50	500,000	4		Basement	4	150	600	Non-fused	St. N. W.-Base	7-4/0	Light =1,379 kw. Power =4,047 hp.	Complete
					21st	3	300	900	Fused & tapped	Base-21st	4(4-300 MCM V.C.)	Demand =1,500 kw.	Complete
					37th	3	300	900	Fused & tapped	21st-37th	4(4-300 MCM V.C.)		Complete
Salmon Towers (Office)	60	649,403	4		Basement	3	300	900	Non-fused	St. N. W.-Base	7-4/0	Light = 974 kw. Power =1,928 hp.	Complete
					22nd	2	150	300	Fused & tapped	Base-22nd	2(4-300 MCM V.C.) 1(4-400 MCM V.C.)	Demand = 940 kw.	Complete
					42nd	2	150	300	Fused & tapped	22nd-42nd	3(4-250 MCM V.C.)		Complete
					59th	3	150	300	Fused & tapped	42nd-59th	3(4-3/0 V.C.)		Complete
Lefcourt (Apt. Hotel)	43	703,000	4		Basement	2	150	300	Non-fused	St. N. W.-Base	7-4/0	Light =1,214 kw.	Complete
					22nd	2	300	600	Fused & tapped	Base-22nd	2(11-4/0)	Power = 770 hp. Demand = 522 kw.	One Bank cut in
					42nd	2	150	300	Fused & tapped	22nd-42nd	2(8-4/0)		Complete
(Office)	30	330,000	4		1st	1	300	300	Non-fused	St. N. W.-1st	7-4/0	Light = 650 kw.	Complete
					21st	3	300	900	Fused Non-tapped	1st-21st	4-600 MCM	Power =1,090 hp. Demand = 630 kw.	Under construction
Farmer's Loan & Trust C (Bank & Office)	56	863,821	4		Basement	4	300	1,200	Non-fused	St. N. W.-Base	7-350 MCM	Light =1,296 kw.	Complete
					21st	4	300	1,200	Fused Non-tapped	Base-21st	4-500 MCM	Power =4,201 hp. Demand =1,780 kw.	Under construction
					54th	3	300	900	Fused Non-tapped	21st-54th	4-500 MCM		Under construction
(Office & Loft)	37	800,840	3		Basement	2	450	900	Non-fused	St. N. W.-Base	2(7-350 MCM)	Light =1,322 kw. Power =1,430 hp.	One bank cut in
					36th	3	300	900	Fused Non-tapped	Base-36th	2(3-800 MCM) 2(1-400 MCM)	Demand =1,110 kw.	Two banks cut in
Nelson Towers (Office & Loft)	48	477,720	3		Basement	3	300	900	Non-fused	St. N. W.-Base	1(7-4/0) 1(7-2/0)	Light = 715 kw. Power =1,420 hp.	Complete
					48th	3	300	900	Fused Non-tapped	Base-48th	4-500 MCM	Demand = 715 kw.	Complete
R. C. A. (Bank & Office)	50	462,288	3		Basement	3	150	450	Non-fused	St. N. W.-Base	7-350 MCM	Light = 693 kw. Power =1,577 hp.	Two banks cut in
					22nd	3	150	450	Fused Non-tapped	Base-22nd	4-500 MCM	Demand = 727 kw.	Under construction
					49th	3	150	450	Fused Non-tapped	22nd-49th	4-500 MCM		Under construction
Empire State (Office)	85 and Tower	2,754,180	5		Basement	5	600	3,000	Non-fused	St. N. W.-Base	2(7-350 MCM)	Light =4,431 kw. Power =9,593 hp.	4 banks cut in
					41st	4	600	2,400	Fused Non-tapped	Base-41st	4-500 MCM	Demand =5,031 kw.	Complete
					84th	4	600	2,400	Fused Non-tapped	41st-84th	4-500 MCM		Complete
City Service (Office)	63	1,046,000	4		Basement	3	450	1,350	Non-fused	Cedar St. N. W.-Base; Pine St. N. W.-Base	2(7-350 MCM); 2(7-350 MCM)	Light =1,345 kw. Power =4,725 hp. Demand =1,963 kw.	Planning
					18th	3	300	900	Fused & tapped	Base-18th	2 tubular buses		Planning
					31st	3	300	900	Fused & tapped	18th-31st	1 tubular bus		Planning
					61st	3	300	900	Fused & tapped	31st-61st	1 tubular bus		Planning

TYPICAL VERTICAL AND HORIZONTAL NETWORK SERVICES—*Continued*

Name and type of building	Stories	Gross floor area (sq. ft.)	Total feeders supplying service 13.8 kv.	3 kv.	Vault location (floor)	No. of banks	Size of banks (kva.)	Initial capacity in vault (kva.)	Charatcer of inter-vault ties	Terminal points of inter-vault ties	Sizes of inter-vault ties	Load and estimated demand	Status of installation
Port of N. Y. Authority Inland Stat. No. 1	15	Offices & Stores, 8th & 9th Aves =273,966			Base (8th Ave.)	0	0	Sec. Ser. Pt.	Non-fused	St. N. W.-Sec. Ser. Pt.	4(3-500 MCM) (1-4/0)	Light =2,258 kw Power =7,775 hp.	Planning
					Roof (8th Ave.)				Non-fused Non-tapped	Sec. Ser. Pt. Roof(8th Ave.)		Demand =4,147 kw	Planning
(Offices & Stores) & Loft & (Warehouse)		Loft Mfg. =997,767 Warehouse =997,767 Total =2,269,500			Base (center)				Non-fused	St. N. W. Base (center)	4(3-500 MCM) (1-4/0)		Planning
					Roof center)				Non-fused Non-tapped	Roof (c)-Base (c) Roof (c)-Roof (8th) Roof (c)-Roof (9th)			Planning
					Base (9th Ave.)	0	0	Sec. Ser. Pt.	Non-fused	St. N. W.-Sec. Ser. Pt.	4(3-500 MCM) (1-4/0)		Planning
					Roof (9th Ave.)				Non-fused Non-tapped	Sec. Ser. Pt. Roof (9th Ave.)			Planning
N.Y.C.R.R. St. John's Park Freight Terminal	12	3,529,000			3rd (Clarkson St.)				Non-fused	St. N.W.-3rd(Clar) 3rd(NC)-3rd(Clar)		Light =1,484 kw Power =5,666 hp	Planning
									Non-fused Non-tapped		4(3-500MCM;1-4/0)	Demand =2,035 kw.	
					3rd (N. Cent.)				Non-fused	St. N.W.-3rd(N.C.) 3rd(S.C.)-3rd(N.C.)			Planning
									Non-fused Non-tapped		4(3-500MCM; 1-4/0)		
					3rd (So. Cent.)				Non-fused	St. N.W.-3rd(S.C.) 3rd(Sp.-3rd(S.C.)			Planning
									Non-fused Non-tapped		4(3-500MCM;1-4/0)		
					3rd (Spring St.)				Non-fused	St. N.W.-3rd(Sp.)	4(3-500MCM-1-4/0)		Planning
(Freight Terminal)									Non-fused Non-tapped				

used so far may be classified as follows according to the arrangement of secondary connections within the building:

1. Isolated or spot networks, also called junior networks in which the energy used at any one point in the building is supplied solely from a plurality of step-down transformers at a single location, there being no secondary ties to any other network.

2. Networks with untapped low-voltage ties wherein the ties connect to other sources and therefore a multiplicity of step-down transformers at any one location are not required. In this case, however, service has to be supplied from the one location over special utilization feeders in the same manner as with a spot network.

3. Networks with tapped ties, the ties being used to distribute load to the several floors between transformer locations.

Each of these types of installation has been used to meet conditions which existed at the time the installations were planned. None of the tapped ties has been installed without fuses. Recent installations, however, are being made with untapped and unfused ties, installed in conduit surrounded by two or more inches of concrete; and in such cases, the building service is supplied locally from each step-down location.

Future Considerations

One of the advantages obtained with vertical network service is the ability to increase the electrical capacity in the building at any time without expensive reconstruction of the original wiring, since each of the several high-voltage cables supplying the building are required for mechanical reasons to have much greater load-carrying capacity than is needed to serve any of the buildings contemplated up to the present time. Of course, the installation of additional distribution transformers would be required either in existing vaults or at new locations nearer the utilization point than the existing vaults; and in addition there would be required the necessary utilization wiring to deliver the new energy to the places in the building where it would be used. Such a procedure is much simpler and less expensive than would be required if the increase were to be supplied from the street network.

All vertical high-voltage feeder installations planned to date have used a dry type of three-conductor shielded cable with an outside wrapping of steel wires with which the cable is held up at the top of its run. It is possible (and obviously desirable) that future developments should make it feasible to use standard types of high-voltage cables for this purpose.

Considering the operating experience in New York City covering a period of about two years, the vertical network installations being made, are regarded to be more than adequate for the service requirements now foreseen. Improvements in methods and in equipment which will simplify the wiring installation and reduce cost may be expected in the future as inspection authorities, architects, and supply company engineers become better acquainted with the special requirements of this type of installation.

News

Of Institute and Related Activities

A-C. Network, Industrial Interconnections, System Grounding Are Subjects of Pittsburgh Meeting

If HEAVY ATTENDANCE and widespread discussion are indicative of the success of technical sessions, then the Pittsburgh District meeting must be adjudged conspicuous in this achievement. Held March 11-13, 1931, with headquarters at the Wm. Penn Hotel, Pittsburgh, it was sponsored jointly by the Institute's Middle Eastern District and the Association of Iron and Steel Electrical Engineers. Official registration exceeded 450, and attendance at several of the sessions was more than 500.

Inspection trips carefully planned to supplement the technical sessions added materially to values and interest. On Thursday evening, March 12, a banquet and dance was held under the joint auspices of the meeting and the Engineers' Society of Western Pennsylvania (Pittsburgh). With W. B. Stellmire (General Electric Company, Pittsburgh) toastmaster, the three speakers on the banquet program were Wm. S. Lee, president of the Institute, Dr. L. A. Hawkins, (General Electric research laboratory) the "Larry" Hawkins of radio fame, and E. C. Stone, vice-president of the Institute's Middle Eastern District.

Important details of the technical sessions are given in the following items. A résumé of discussions will appear in an early issue of Electrical Engineering.

A-C. Network Symposium Attracts Wide Attention

Two out of five technical sessions were devoted to six papers and extensive, prepared discussion pertaining to the development of the a-c. network in electric power distribution. Three of these papers dealt with the development of underlying theory, having to do with low-voltage electric arcs; the second group of three papers related to the physical and economic aspects of the network idea itself.

Discussing "Burn-Off Characteristics of A-C. Low-Voltage Network Cables," George Sutherland and D. S. MacCorkle, of the New York & Queens Electric Light & Power Company, described extensive tests made to determine the characteristics of the clearance of faults in different types of a-c., low-voltage-network, copper-conductor cables installed in accordance with present standards of underground construction. Upon analysis of their test results and other data, the authors reached the following conclusions:

1. If A 3,000-ampere current is available, faults in the class of point contacts occurring in single-conductor, low-voltage cables operating at voltages from 120/208 usually clear within a few seconds irrespective of conductor size.

2. Copper-to-copper faults in single-conductor, low-voltage cables usually clear at the point of fault within one minute or less (for example, 3,000 amperes on 4/0 cable).

3. Size for size, the burn-off characteristics of non-magnetic-sheath cables dropped at random in a trench are the same as those of cables installed in 4-in. non-metallic ducts.

4. The burn-off characteristics of multiple-conductor, buried, non-magnetic-sheath cables make that type of construction undesirable for low-voltage, a-c. network distribution.

5. Analyses show no appreciable difference between oiled-paper and rubber insulation in the explosiveness and inflammability of gases produced by lead-covered cables.

J. Slepian and A. P. Strom of the Westinghouse research laboratories presented the subject "Arcs in Low-Voltage A-C. Networks." They reviewed the information pertaining to the extinction of a-c. arcs at current zero, and defined arc-reignition characteristics and circuit-reignition characteristics. Based upon studies of arc-reignition characteristics of short arcs between metal electrodes and non-adjacent to installation, the authors concluded that such arcs are incapable of interrupting practical low-voltage a-c. network circuits. They ascribed the extinction of arcs in practical network cables to the deionizing action of gas blast arising from burning insulation. It is claimed that experiments with arcs in cables, and arcs between parallel plates remote from insulation in some cases and closely bounded by insulation in other cases, confirmed this view. The authors stated that inorganic insulating materials also may assist in arc extinction through the generation of gas blast arising from their decomposition. In this connection boric acid was found to be the most effective material. It was stated also that the charring of organic insulation may be expected to cause an insulation to lose its arc-extinction-aiding characteristics.

Laboratory results bearing upon the "Reignition of Metallic A-C. Arcs in Air," were presented by S. S. Attwood and W. G. Dow, of the University of Michigan, and W. Krausnick, of Ohio Northern University. The authors were in search of experimental evidence of the current-voltage-time relations that exist during the period when an a-c. arc between metallic electrodes passes through its cyclic current zero. Twenty-nine cathode-ray oscillograms revealing certain characteristics of these relationships were presented. The authors stated that during the current-zero period the arc-electrode voltage is determined by the circuit constant, and rises until the electrode voltage reaches the breakdown or reignition value determined by the deionizing influences at work while the arc is extinguished. Alteration of the circuit constants permits a variation in the rate of voltage rise, with a consequent change in the reignition voltage. In the opinion of the authors the action of a circuit breaker in extinguishing an arc is greatly influenced by the presence of adjacent load circuits and by the presence of distributed inductance and the capacity in the connecting lines.

Some typical applications of the network distribution idea to power distribution within tall office buildings were outlined by A. H. Kehoe of the United Electric Light & Power Company, New York, and Bassett Jones, consulting engineer, New York. This paper appears practically in full on pages 292-95 of this issue.

C. T. Sinclair and R. M. Stanley, of the Byllesby Engineering & Management Corp., Chicago, presented their design of "A Primary Network." The primary network was characterized by its proponents as setting up the means for system growth and expansion, very largely obviating the need of extensive and expensive system planning. The primary network described is similar in general characteristics to the low-voltage network, particularly in so far as the inter-connection of the secondary mains is concerned. The authors contend that in spite of the fact that two transfor-

mation steps are required in the primary network described, compared with the one required in the low-voltage network the primary network has economic possibilities which should be considered seriously for areas of medium-load density. Such a network now is in course of construction in the Pittsburgh area and many persons interested took advantage of an inspection trip arranged to demonstrate this feature.

"The Philadelphia A-C. Network System," was described by H. S. Davis, and W. H. Ross, of the Philadelphia Electric Company. The system in question consists of sectionalized primary-loop feeders supplying a fused-secondary network. At present there are twenty-four of these feeders in operation with a normal total operating capacity of 32,540 kva. The feeder peak thus far experienced was reported to have been 27,600 kva. As a result of five years of operating experience, during which period normal load growth and developments have been cared for, the authors have reached the conclusion that the system adopted has proved amply flexible to meet changing conditions, and that operating experience has been completely satisfactory under all conditions including times of faults on the network or elsewhere on the system.

Symposium On System Grounding

"Present Day Practise in Grounding of Transmission Systems," was comprehensively outlined in a committee report presented by C. A. Powel of the Westing house Electric & Manufacturing Company, chairman of an A. I. E. E. subcommittee on grounding.

J. E. Clem, General Electric Company, in his paper "Reactance of Transmission Lines with Ground Return," presented an analysis of a theoretical circuit consisting of any number of line conductors in parallel with a return to earth, and any number of ground wires in parallel. The paper is an added contribution of this author toward simplication of the calculation of ground faults, an essential factor in the prediction of system stability limits. In addition to his analytical study, the author presented confirming field test data and suggested a method of predicting the impedance of the fundamental circuits of a conductor with a ground return.

A "Fundamental Basis for Distance Relaying on Three-Phase Systems," was described by W. A. Lewis of the Westinghouse company, and L. S. Tippett, formerly of the same company. As a result of an extensive investigation into the subject, and based upon equally extensive supporting mathematics, the authors reach the conclusion that:

1. Conventional methods of distance relaying are subject to errors other than those caused by fault impedances.

2. Such errors may be eliminated in relays protecting against line faults by the use of the proper delta-connection of current transformers or relays.

3. That such errors may be eliminated in relays protecting against ground faults by the use of voltage or current compensation.

4. The limitation of application of distance relaying is the error introduced by the presence of fault impedance, which affects both impedance and reactance relays, but each to a different extent.

5. Distance relaying may be made to approach even more closely the desired relaying ideal and that within the limits of its application it should give satisfactory protection regardless of generator capacity or system conditions.

Under the title "Power System Voltages and Currents Under Fault Conditions—Effect of Sequence Impedances" R. D. Evans and S. H. Wright of the Westinghouse company presented the results of an investigation of the general characteristics of power systems under unbalanced fault conditions, giving particular attention to the range of voltage and current that may exist under such conditions. The authors made their analysis by the method of symmetrical components, giving attention to the range of the sequence impedances of power systems. They presented numerous curves and in general gave their results in a form offering a direct comparison of the characteristics of different systems. As a result of their study the authors have concluded that on three-phase systems:

1. The currents and the voltages under abnormal conditions may vary over a wide range depending upon the sequence impedances and the location and character of the fault.

2. The line-to-ground voltage may rise to twice the normal line-to-neutral voltage, and the ratio of line and ground current to the three-phase short-circuit current may be as great as 2.0 and 3.0, respectively.

3. The ground current on a double line-to-ground fault may be 50 per cent greater than the maximum value of a single line-to-ground fault.

The authors stated further that the range of voltages and currents on actual systems is determined principally by the ratio of the zero-sequence impedance to the positive-sequence reactance. They considered the zero-sequence-impedance ratio as a convenient criterion in connection with system grounding, and suggested that the preferred value of this ratio is in the range of from 1 to 4.

"Simultaneous Faults on Three-Phase Systems" were most ably and mathematically discussed by Miss Edith Clarke of the General Electric Company. The author extended the method of symmetrical components to apply to a three-phase system during simultaneous faults at two or more points of the system, and developed a general equivalent circuit replacing (in the positive-phase diagram) two simultaneous faults involving any combination of the six conductors. Further applications of the general method were discussed, and numerous typical cases were worked out in detail by the author, who stated that the methods and formulas given in her paper were developed in answer to such questions as:

1. Which is the more severe shock to a system, a double line-to-ground fault in one circuit or two single line-to-ground faults occurring simultaneously on two separate circuits?

2. Do simultaneous double line-to-ground faults which involve the same phases (*a* and *b*) on two circuits result in more, or less ground current than do faults which involve phases *a* and *b* on one circuit and phases *b* and *c* on the other?

Industrial Power Applications

Power usage, particularly as it affects power supply for large industrial establishments, was the central theme around which was built an important program for a joint session with the Association of Iron and Steel Electrical Engineers, and sponsored by that organization. Many significant phases of some of the more important problems arising from heavy-duty electric power interconnections between large industrials and the electric utilities were treated in the light of both engineering and economics by the several papers and by most of the large number of prepared discussions presented at the session. Perhaps the most vital single point brought out in the entire session was the fact that such interconnections, whether for one-way power supply or for the interchange of power between utilities and industrials, must show definite advantages and profits to both parties if such contacts are to remain in force for any length of time.

F. O. Schnure, of the Bethlehem Steel Company, outlined the three interconnection plans now in common practise as:

1. Where the utility furnishes all the power used by the industrial.

2. Where the utility furnishes peak power for the industrial with the latter supplying its own base load.

3. Where the utility furnishes the base load for the industrial, with the latter supplying its own peak power.

The author gave as a fourth possibility, that in which the utility purchases from the industrial surplus power, and stated that in his opinion the greatest economies for each party are to be found in the potentialities of interchange.

Operating experiences arising from the interconnection between the Duquesne Light Company and the Davison Coke & Iron Company, Pittsburgh, were given in a paper jointly prepared by G. E. Dignan, chief engineer of the Davison Coke & Iron Company, and R. I. Kirk, Duquesne Light Company.

Under the title "Absorption of By-Product Power," A. Hoefle of the Toledo

(Ohio) Edison Company, and W. T. Woodmany, of the Interlake Iron Corp., said in part:

Complete and economic utilization of by-product is an end much to be desired in modern industry. Studies that have been made with reference to such an end have frequently revealed promising opportunities for cooperation between manufacturing plants and electric utilities. Some combined arrangement often will prove to be of economic benefit to both parties.

The basic idea in a coordination scheme lies in the construction of efficient stations to operate at a good load factor by feeding into the utilities' systems whenever the manufacturers' demands for steam or by-product power drop off. Some of the methods of accomplishing this result are:

1. Use in the utility's plant of industrial by-products representing excess energy.

2. Sale of exhaust steam supplied by a central station's generating plant to a manufacturing establishment for process purposes.

3. Transfer of excess power generated in the manufacturer's generating plant to a utility system.

4. A joint arrangement in which manufacturer and utility own and operate a generating station and share the fixed and variable costs in proportion to benefits derived.

The authors gave examples upon which they based their conclusions.

A detailed discussion of some of the many problems entering into the question of electric power distribution within a large industrial establishment was given in a paper prepared jointly by R. D. Abbiss of the Carnegie Steel Company, and D. C. West of the Westinghouse company.

The application of electrically-heated annealing furnaces for steel and other industries was described quite completely by J. C. Woodson of the Westinghouse company. After describing present practises and considering current operating experiences with the equipment in question, the author offered the following predictions as to the future:

1. A rapid and extensive expansion of electric annealing to wire strip and sheet mills generally to meet economic limitations and competitive costs.

2. The use of artificial furnace atmospheres to secure special and better results in fabricating and manufacturing processes.

3. There will be developed more of the large continuous electric furnaces for sheet annealing and normalizing, and with artificial atmospheres.

4. An extensive development and application of the principles of inductive heating to numerous heat-treating processes now considered unsuitable.

"A Modern Electrified Dairy Plant" described in a paper prepared jointly by A. J. Dreux of the Rieck-McJunkin Dairy Company, Pittsburgh, and H. C. Brunner of the Westinghouse company reflected another important application of electrical equipment. This paper is presented essentially in full elsewhere in this issue.

Power Supply For Communication Systems

In describing "Automatic Power Plants for Telephone Offices," R. L. Young, American Telephone and Telegraph Company, and R. L. Lunsford, Bell Telephone Laboratories, laid particular stress upon the exceptionally high degree of reliability in electric power supply that is essential for a telephone system. They described in detail unit-type power plants that have been developed for telephone offices, and mentioned the fact that the operating reliability record of modern equipment of this type is 99.9996 per cent.

A description of similar equipment developed for telegraph service was presented by E. W. Griffith of the Western Union Telegraph Company, in his paper "Telegraph Power Plants." The author traced the development of telegraph power plants from the era of the gravity battery down to the present combination of automatic equipment and storage battery.

Radio communication came in for its share of the discussion with a description presented by R. L. Davis of the Westinghouse company covering the power equipment at the new high-powered KDKA broadcasting station, and a lucid description of "Recent Developments in the Operation of Overseas Radio Telephone Service," presented by F. A. Cowan, of the American Telegraph and Telephone Company.

Students Active at Pittsburgh Meeting

At the district conference on student activities held March 12, 1931, in conjunction with the Pittsburgh meeting of the Middle Eastern District, each of the first two subjects was presented by two speakers, one representing industry and one representing the student point of view:

Summer Employment for Engineering Students
- W. D. Bruce, chairman, University of Pennsylvania Branch, and
- O. W. Eshbach, Personnel Department, American Telephone & Telegraph Company.

Qualifications Looked for in a Cadet Engineer
- Harmon Shively, chairman, University of Akron Branch, and
- E. B. Roberts, Educational Dept., Westinghouse Electric & Mfg. Co.

These topics were discussed by many present, and the following resolution was adopted:

Be it resolved that:

1. In view of the continued industrial depression with the resultant inability of industry to absorb the 1931 graduates, the technical colleges in the Middle Eastern District be requested to present to the senior classes the desirability of continuing their educational program; and furthermore that the college authorities be requested to seriously consider extending as much assistance as possible to students capable of profiting by this program.

2. The Chairman of this Committee be charged with the duty of forwarding this resolution to the college governing boards in the Middle Eastern District.

The third topic, "Has the Student Branch any Responsibilities to Freshmen and Sophomores?", was presented by C. L. Lucal, incoming chairman of the Ohio State University Branch, and W. J. Lattin, incoming chairman of the Case School of Applied Science Branch.

Professor J. T. Walther, counselor, University of Akron Branch, and vice-chairman and secretary of the district committee on student activities, presented a comprehensive report on the Branch activities in the district during the present academic year. This was followed by brief reports by several speakers giving additional information concerning the meetings of certain Branches.

Eleven of the eighteen Branches in the district were represented by their counselors and chairmen, and two others by the chairmen only.

Luncheons

Prior to the student conference a joint luncheon meeting of the counselors and chairmen was held. At this Professor Morland King presided and brief addresses were given by E. C. Stone, vice president of the Middle Eastern District; F. L. Hutchinson, national secretary; and Henry H. Henline, assistant national secretary.

Vice-president Stone stated that the fundamental purpose of the Branches is to make better electrical engineers. He emphasized the importance of contacts between students and electrical engineers, and the benefits to be derived by students from the preparation, presentation, and discussion of papers. Mr. Hutchinson and Mr. Henline also spoke of the benefits available to students who participate in Branch activities. Mr. Henline gave a brief summary showing the great increase in student participation during recent years.

Separate luncheons were held March 13 for the counselors and for the Branch chairmen. At the Counselors' luncheon, it was decided that the next district conference on student activities will be held in the spring of 1932 in conjunction with the annual student convention of the schools in and near Philadelphia.

Professor J. T. Walther, counselor of the University of Akron Branch, was elected chairman of the district committee on student activities; Professor Lewis Fussell, counselor of the Swarth-

more College Branch, was elected vice-chairman and secretary, both to take office August 1, 1931.

Directors Meet at Pittsburgh Gathering

The regular meeting of the Board of Directors of the American Institute of Electrical Engineers was held at the William Penn Hotel, Pittsburgh, Pa., Thursday, March 12, 1931, during the Middle Eastern District meeting. Present were:—

President: W. S. Lee, Charlotte, N. C. —Past-president: R. F. Schuchardt, Chicago, Ill.—vice-presidents: Herbert S. Evans, Boulder, Colo.; W. S. Rodman, Charlottesville, Va.; E. C. Stone, Pittsburgh, Pa.; C. E. Sisson, Toronto, Ont.; G. C. Shaad, Lawrence, Kans.; H. P. Charlesworth, New York, N. Y.—directors: F. C. Hanker, East Pittsburgh, Pa.; E. B. Meyer, Newark, N. J.; F. W. Peek, Jr., Pittsfield, Mass.; C. E. Stephens, A. E. Knowlton, New York, N. Y.—National Treasurer W. I. Slichter, and National Secretary F. L. Hutchinson, New York, N. Y.

Ratifications

Minutes of the directors' meeting of January 28, 1931, were approved.

A report of a meeting of the board of examiners held February 18, was presented and approved. Upon its recommendation the following elections were made of applications pending: 290 Associates; 13 Members; one Fellow. Transfers: 40 to grade of Member, and six to grade of Fellow.

In accordance with Sec. 22 of the constitution, S. L. Foster, E. E. Keller, and Wm. Lispenard Robb were exempted from future dues, and their names added to the list of "Members for Life."

The finance committee's approval of February bills amounting to $31,161.18, ratified. Decision was made to accept the invitation of the Cleveland Section and hold the 1932 summer convention at Cleveland, Ohio.

The board confirmed the president's appointment of the following committee of tellers to canvass and report upon ballot of election for Institute officers: P. C. Jones (chairman), Henry Kurtz, E. J. O'Connell, Hugh L. Smith, W. Y. Vedder, E. Volckmann, and J. T. Wells.

L. A. Ferguson was reappointed the Institute's representative on the Commission of Washington Award.

For appointment by the president of the National Academy of Sciences, H. P. Charlesworth was nominated as a representative of the Institute on the Division of Engineering and Industrial Research of the National Research Council, to succeed Dr. F. B. Jewett, whose term expires July 1, 1931, reappointment denied.

An invitation for September 21-25, 1931 from the Royal Institution of Great Britain to send a delegate to centenary celebration of Michael Faraday's discovery of electromagnetic induction was accepted, and the president empowered to appoint delegate and alternate.

Invitation was accepted to send a delegate to the celebration October 1-2, 1931, at the University of Cambridge, England, commemorating the birth of James Clerk Maxwell. The board also accepted invitation to be represented at the inauguration of President Chase, University of Illinois, May 1, 1931.

Resolution was adopted expressing the board's appreciation of various Pittsburgh meeting committees, in their excellent arrangements for the meeting and the effective manner in which plans were carried out.

Other matters were discussed, reference to which may be found in this and future issues of Electrical Engineering.

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Some Winter Convention Discussions are Summarized—Part II

A SUMMARY of some of the many discussions presented at the last five sessions of the 1931 winter convention is given herewith. A similar summary covering some of the discussions presented at the first four sessions of the convention was given on pp. 226-228 of Electrical Engineering for March 1931. Only discussions submitted in writing in accordance with A. I. E. E. rules governing it is summarized; complete discussion together with all papers so approved will be published in the Transactions. A list of papers presented was published in the January issue of Electrical Engineering, pp. 52-53.

Industrial Power Applications

Electron Tubes

H. S. Phelps discussed the use of a photoelectric switch for control of street-lighting circuits. An operating test of this device has disclosed a close approximation to the municipal schedule in effect and it has extended both the night and morning scheduled lighting period on cloudy or stormy days.

J. V. Breisky in his discussion classified the various types of tubes in general, and in particular the family of grid-controlled gas-filled tubes which he subdivided into three groups; cold-cathode tubes, hot-cathode tubes, and tubes employing a pool of mercury for a cathode. The characteristics of each class were described. In conclusion Mr. Breisky predicted that during the next few years a tremendous increase in this activity would take place, particularly when the larger tubes become standardized and are generally available.

C. R. Sharp cited an important application of photoelectric cells and electron tubes; namely, the photometry of incandescent lamps. He explained that the caesium cell has red sensitivity and is applicable for photometric purposes when the color between the lamps to be measured lies within the ordinary range of commercial lamps.

Automatic Regulators

In connection with discussion of this subject, S. Minneci described a system of automatic control for load-ratio control wherein a contact-making voltmeter is used as the master element. The control circuit is arranged similarly to that used with induction voltage regulators except that an adjustable time delay relay is inserted between the contact-making voltmeter and the motor-reversing contactor at the operating mechanism.

R. G. Standerwick discussed the performance of hydraulic regulators on turbine installations. Charts were shown illustrating the regulation of a 10,000-kw. speed-regulated turbine tied in with a second machine of 6,000 kw. capacity and operating over a wide fluctuation of electrical load.

Plant Distribution Systems

G. S. Merrill in his discussion of the section of the paper dealing with general-purpose indoor lighting pointed out that interest, taxes, depreciation, and the cost of electrical losses, are elements in the cost of producing light that should be taken into account in determining how the maximum amount of light per dollar in a new installation can be obtained. For the case in the paper where energy costs 1½c. per kw-hr. lamps operated at normal voltage will produce light at a unit cost about 2 per cent lower than if they were operated 5 volts under their labeled voltage.

A. B. Smedley discussed the cable and wire phases of the subject with particular reference to non-metallic, sheathed,

underground cables. He pointed out that cable manufacturers have done much development work in perfecting the non-metallic materials and compounds. Particular attention has been directed toward the possible elimination of materials of high-thermal resistivity and the tensile strength has been greatly increased without sacrificing flexibility.

Special Synchronous Motors

Fraser Jeffrey in discussion of the subject pointed out that notwithstanding the high cost of the so called synchronous induction motor and its use being restricted principally to high-speed drives, such machines are being successfully applied to low-speed high-inertia drives at costs competitive to other modified types of salient-pole machines.

F. K. Brainard in his discussion of the subject made comparisons between induction motors and synchronous motors within the various speed ranges. The comparison is usually favorable to the synchronous motor up to speeds of 1,200 r. p. m. although it depends largely upon the value of reactive kva. in the particular installation.

Transportation Session Discussion

Suburban Electrification

H. M. Trueblood discussed the paper "Lackawanna Suburban Electrification" from the standpoint of inductive coordination because this is the first electrification in the United States using rectifiers as the sole source of propulsion power; the contact-wire voltage is 3,000 volts. He pointed out that the results of field tests conducted under severe conditions indicated that the Bell System plant which is located in close proximity would experience little or no difficulty from induction or ground potentials.

One of the points commented upon by W. B. Potter in his discussion of the same paper was the method of putting the air intake for motor ventilation at the top of the car, thereby eliminating much dirt and brake-shoe dust from the motors.

C. H. Lydall discussed the paper and described a 3,000-volt d-c. electrification in South Africa where at first considerable trouble was caused by lightning. Later, however, the trouble was eliminated entirely by the installation of high-speed circuit breakers on the feeders to the track.

H. F. Brown in discussing the subject "Motive Power for Suburban Electrification," indicated that the conclusions reached in Mr. Kerr's paper agreed more or less in all points enumerated with the results obtained by the New Haven Railroad during twenty or more years of a-c. operation of electric suburban traffic.

Inclined-Catenary Calculations

W. B. Potter discussed the subject and in his opinion the type of structure given in the paper does not provide for the same flexibility on curves as the chord system. The contact between the line and the collector is best assured by flexibility of the line.

H. F. Brown commented favorably upon the paper by saying that not only did it present a valuable addition to the meager literature existing on inclined-catenary design, but also it has simplified somewhat the calculations required both in the development of the shape factors, and in their application to the track alinement.

N. Litchfield in his discussion of the subject pointed out that the so called "curved" or "inclined" catenary was originated by the engineers of the New Haven Railroad in 1909. To accommodate longer spans with sharp curves, particularly transition curves, the original method of calculation was modified in 1913-14 by Messrs. H. S. Richmond and Philip Goldstone, and has become practically the standard method in general use. In conclusion it was stated that Mr. Picken's paper is well worked out and should be of interest to all catenary designers.

H. S. Richmond discussed the subject and stated that in his opinion equation (33) of the paper is not significant because the *U*-curve practically approximates the circle and most track curves are not actually so uniform.

J. B. Colley in his discussion of the subject outlined a method of calculation for the transition curve which he believed is shorter than the method given in the paper and although not so exact, seems to be within the bounds of practicability.

H. F. Brown discussed "Design of Catenary System for Cleveland Union Terminal." He drew attention to the temperature movements of the center of 250- or 300-ft. spans where a bronze messenger is used instead of steel messengers. He also commented on the use of chains for suspension and pull-off members, which he pointed out are subject to vibration, weather, and corrosion, and in the course of a few years are liable to wear very thin. In his opinion such parts should be reduced to a minimum.

Electric Welding Session Discussion

S. Dushman discussed "Arcs Between Metal Electrodes" stating that one of the most important results to follow from this investigation is the conclusion that the transition from the glow to the arc (or vice versa) is governed more by the current density at the cathode than by the temperature of the latter. He discussed the conclusions from the point of prevalent theories on the phenomena occurring in the transition from glow to arc and on the origin of electrons at the cathode of an arc discharge.

C. G. Found's discussion of the same subject was presented by Dr. Dushman. He commented on the paper as being a valuable contribution to the study not only of arcs but also of general discharges in gases, particularly the transition stages from the normal to the abnormal glow and from the abnormal glow to the arc.

J. Slepian discussed the paper raising the questions, (1) may not the transition states observed by the authors be only apparently equilibrium transition states? (2) May they not consist of very rapid alternations between the glow states and the high-current density arc state? He called attention to the fact that these alternations might take place with such high frequency as to escape detection on the oscillograph used by the authors.

A. Churchward discussed "An Improved Arc-Welding Generator" stating that early in 1924 he had used the transformer reactor on a self-excited drooping welding generator, and his tests confirmed the results in the paper.

D. W. Ver Planck discussed "The Neutralized Welder" and commented on the fact that the paper demonstrated that the steady-state and some of the transient characteristics of welding generators can be determined analytically. He was of the opinion that the equivalent circuit method which leads to the same results is considerably simpler than the method described in the paper.

D. W. Ver Planck also discussed "A System for D-C. Arc Welding." He presented a method of analysis which showed to what particular quality of the machine each part of the transient was due, and would suggest to the designer the way in which any part of the transient might be emphasized or suppressed. The current transient following a short circuit can also be handled in a similar fashion, though with somewhat less ease.

Research Session Discussion

H. H. Race discussed "Conductivity of Insulating Oils—II." He commented on the paper pointing out that the author deserves considerable credit for developing sensitive apparatus for determining short-time d-c. characteristics. The conclusions, if correct, will have a far-reaching effect upon the development of the theory of liquid dielectrics. Several reasons why the initial exponential portion might be due to an oscillographic error rather than a characteristic of the oil were given by H. H. Race in his discussion. He also inquired as to the meaning of "dielectric absorption" in connection with the results.

Cable Oils

J. B. Whitehead discussed "Some Electrical Characteristics of Cable Oils." He pointed out that no quantitative relation had been found heretofore between the one-minute or long-time d-c. conductivity and the actual values of dielectric loss at various frequencies. He believed Dr. Race went a little too far in the suggestion in his paper that the one-minute d-c. conductivity is a sufficient indication of the a-c. properties of the oil.

One of the points discussed by W. B. Kouwenhoven in his discussion of "Electrical Characteristics of Cable Oils" was the curve in Fig. 6 showing the variation of resistivity of oil with temperature. He gave data on resistivities of two oils at 1,500 volts, taken at various temperatures at a voltage gradient of 25 volts per mil made at four mil-seconds to 40 minutes after the application of voltage. When these data are plotted on semi-log paper the 40-minute values fall on straight lines of a slightly greater slope than those given in the paper. The four mil-second values did not give a straight line relation when plotted as in Fig. 6. The resistance of oil varies not only with temperature but also with the time after the application of voltage.

In connection with the discussion of "The Conductivity of Insulating Oils," S. K. Waldorf replied to H. H. Race's questions concerning the oscillograms; he explained that the response of the apparatus to d-c. impulses was recorded and that it was shown that the oscillograph vibrator used was over-damped rather than under-damped and it did not over-travel. He also explained that deflections were measured to a tenth of a millimeter which on oscillograms having the smaller deflections gives a current value accurate to within about 5 per cent or better. With larger deflections, the accuracy of such measurements is of the order of 1 per cent and better.

C. L. Dawes discussed "Fundamental Properties of Impregnated Paper." He discussed the so called *V* or *U* curves of the power loss in impregnated-paper insulation as a function of temperature and pointed out the value of the paper in giving a definite explanation, (substantiated by experiment) for these curves.

Traffic Control by Light Beams

F. Hamburger, Jr. discussed this subject and in his opinion a twelve-second green light for minor street traffic where traffic is light was too long. He asked if it was not possible with the control described in the paper to set the minor street green for six seconds and provide a step-up feature or time extension to permit a longer minor street green in the event of several cars following one another?

Commutation in Hydrogen

T. T. Hambleton's discussion of this subject was read by Mr. Linville. He reported results of tests made on a 3,000-kw., 10,000-ampere, 60-cycle, 300-volt, converter which was operated in a gas-tight enclosure of hydrogen. The results showed a reduction in windage loss amounting to approximately 25 kw. and an increased cooling efficient. The rating of the converter when operating in hydrogen could be increased 25 or 30 per cent with approximately the same ultimate temperatures in the current-carrying parts as were reached at the lower rating when operating in air.

Non-Linear Circuits

V. Karapetoff discussed this subject and mathematically analyzed his conception of one of the series circuit conditions.

E. Weber discussed the subject and gave a fundamental analysis of the distortions shown in the waves of the current and voltage drops across the reactor and capacitance. His fundamental analysis showed that this phenomenon is quite in accord with ordinary series resonance of the double-energy linear circuit, and differs only in that it exists for only a small part of the period.

Electrical Machinery Session Discussion

C. R. Boothby discussed "Induction Motor Slot Combinations" and brought out that while appreciable "hooks" are indicated in many of the speed-torque curves shown in the paper, for most commercial applications these would not be unsatisfactory. Combinations which are noisy at low speeds often are very quiet at normal operating speeds.

H. C. Specht, in his discussion of this same subject, (read by C. R. Boothby) doubted if the theory of revolving permeances was any more useful in simplifying the problem of noise and cusps in the speed-torque curves of induction motors. He commented upon a number of the rules given in the paper and believed that the reader would profit a great deal more from the valuable data given if it were clearly shown how the ten rules were derived from the mathematical work.

L. A. Doggett also discussed the paper and expressed hope that the author would go a step farther and give tables recommending the number of slots for the more common cases. Upon trying to apply the rules given by the author to the case of a two-pole, three-phase machine it was found that all possible values of rotor-slot numbers were eliminated by one or more of the ten rules.

The Pulling Into Step of a Salient-Pole Synchronous Motor

D. W. McLenegan and I. A. Terry discussed this subject and commented on the value of the M. I. T. integraph in solving problems which are very difficult to treat analytically. They described tests on a 75-hp., three-phase, 900-r. p. m., 0.80-power factor, synchronous motor to determine the effect of the field time constant upon the pull-in characteristics. Results of these tests show that due to ideal timing of the instant at which the field is applied a motor may pull into step from a slip greater than that indicated by formula (**5**) in the paper.

V. Bush discussed the paper with particular reference to the integraph and the stroboscope. He explained that a new integraph was now under construction which would be capable of solving total differential equations of very considerable complexity and with much better precision than was possible with the present machine. He also commented on the new stroboscope and the very large light intensities produced. He explained that Mr. Edgerton used a stroboscope which had a period of illumination of only about 10 microseconds occurring once each cycle and yet was able to obtain sufficient light for photography.

Heat Losses in Large Turbine Generators

C. J. Fechheimer discussed this subject and commented on the complexities of the problem. He pointed out that by modifying the boundary conditions the author has simplified his solution and has put it into workable form by substituting equivalent electrical circuits for the heat circuits.

K. K. Palueff discussed the paper and described how a short-circuit table such as is used for the analysis of short-circuit characteristics of transmission systems could be employed to solve thermal problems similar to those mentioned by the author.

One of the points discussed by D. S. Snell in his discussion of the subject was the assumption made in the paper that the plane of division of radial heat flow in the tooth region is at the bottom of the slot. He pointed out that while this assumption is justifiable for turbine generators with radial ventilating ducts in both stator and rotor, it might give temperatures very much higher than the actual for turbine generator rotors of the solid-forged type with ventilating channels below the coil slots.

The Non-Resonating Auto Transformer

F. J. Vogel discussed this subject and one of the points which he brought out

was that experience in the design of transformers has indicated always that practically the entire surge voltage is across the series part of the winding whether or not the low-voltage line is connected; and good insulation practise has been established on this basis. He also discussed interleaved windings and submitted a figure which shows the initial distribution and oscillations within the winding. All the stress is distributed over the series part of the winding and high voltages do not prevail at points of discontinuity as claimed in the paper.

Rochester Meeting Features Noise Abatement and Lightning Studies

An attractive program consisting of four technical sessions and entertainment with a special program for the ladies and a number of interesting inspection trips has been arranged by the Local Committee for the meeting of the North Eastern District of the A. I. E. E. to be held at Rochester, April 29 to May 2. Headquarters will be at the Sagamore Hotel.

Because of its location Rochester is readily accessible from all points in the East and is possessed of scenic beauty of unusual interest. It is particularly noted for its fine residential sections, being known throughout the Empire State as the "city of homes." Also of importance is its manufacturing center; several of the large plants located in the city will be open for inspection to members and their guests.

Technical Sessions

The first two technical sessions are on selected subjects; the third will present a symposium on noise, and the fourth session, a symposium on lightning. The selected subjects offer a variety of papers, some on cables, others on special transformers, cusps in the speed-torque curves of induction motors, and equivalent circuits of imperfect condensers.

Joint Session on Noise Abatement

With the object of outlining a broad and efficacious program on "noise investigation" and in worthy conclusion of the morning session at which will be presented a symposium on "Noise in Electrical Machinery," a joint meeting will be held on the evening of April 30, 1931, at which the N. E. L. A., N. E. M. A., A. S. M. E. and A. I. E. E. will all be capably represented. The morning symposium will include methods of noise reduction, described by Westinghouse engineers, the manufacturers' view of the noise problem summarized by Prof. B. F. Bailey, University of Michigan, chairman of N. E. M. A. committee on noise, and a paper by E. A. Bishop of the Commonwealth Edison Company, Chicago, on the mitigation of noise in substations.

Entertainment

An informal reception, with dancing and card playing will be held on Wednesday evening. The following evening will be devoted to an inspection of the Eastman Theater and Eastman School of Music. The theater is reputed to be one of the most beautiful in the country, and the School of Music, in the short time it has been operating, has achieved international distinction. The theater will offer a performance of current attraction.

The Meeting Dinner

A dinner will be held on Friday evening, when H. H. Sullivan, past-president of the Rochester Engineering Society, will act as toastmaster, and Professor Walter King Stone of the College of Architecture, Cornell University, will give an address on "What the Artist May Contribute." Entertainment and dancing will follow the presentation of district prizes.

Ladies' Entertainment

In addition to the foregoing entertainment, the Ladies' Committee has arranged a special program of luncheons, a luncheon and bridge at the home of Mrs. H. H. Sullivan, and sightseeing trips to some of Rochester's most scenic points.

Ladies' Program

Wednesday, April 29

9:00 a. m. Registration at meeting headquarters
12:30 p. m. Luncheon at Sagamore Hotel
2:00 p. m. Sightseeing trip
8:00 p. m. Reception at Sagamore Hotel

Thursday, April 30

Morning free for shopping
1:00 p. m. Luncheon and bridge at the home of Mrs. H. H. Sullivan
7:30 p. m. Inspection of Eastman Theater and Eastman School of Music, including a performance of current attraction

Friday, May 1

12:00 m. Luncheon
2:00 p. m. Sightseeing trip
7:00 p. m. Dinner

Inspection Trips

A program of interesting and profitable inspection trips to large and well-known manufacturing plants in Rochester also to the utility interests and the University of Rochester has been scheduled for Thursday afternoon and Saturday morning. In addition, several inspection trips for the students have been arranged for Friday afternoon at 2:00 p. m.

Hotel Reservations

Reservations at the various hotels are available by writing to O. L. Angevine, executive secretary of the Rochester Engineering Society, 111 East Avenue, Rochester, N. Y. A form for this purpose will be mailed with announcement to the membership; also a list of the rates for the various hotels.

Committees

The personnel of the district meeting committee consists of: I. E. Moultrop, vice-president, North Eastern District, chairman; A. C. Stevens, secretary-treasurer, North Eastern District; J. N. Alberti; C. W. Henderson; E. C. Karker; C. H. Kline; H. J. Klumb (chairman of the local executive committee); R. G. Warner; and F. C. Young. The officers of the general committee are: E. C. Karker, chairman; F. C. Young, secretary-treasurer; H. S. Collins, assistant secretary-treasurer. The following are chairmen of the various subcommittees: O. L. Angevine, hotels and registration; V. M. Graham, inspection trips and transportation; O. L. Angevine, publicity; J. G. Carritt, entertainment and banquet; W. H. Reichard, sports; H. J. Klumb, finance; Mrs. O. L. Angevine, ladies' entertainment.

Tentative Program

(Eastern Standard Time)

Wednesday, April 29

9:00 a. m. Registration

10:00 a. m. Welcoming addresses:

Stephen B. Story, City Manager

Virgil M. Palmer, Rochester Engineering Society

10:20 a. m. Session on Selected Subjects

Temperatures in Electric Power Cables under Variable Loading, E. A. Church, Edison Electric Illuminating Company of Boston.

Proximity Effect in Cable Sheaths, H. B. Dwight, Massachusetts Institute of Technology

Cusps in the Speed-Torque Curves of Induction Motors Due to Space Harmonics, P. H. Trickey, Westinghouse Electric & Mfg. Co.

Losses in Transformers for Use with Mercury Arc Rectifiers, E. V. DeBlieux, General Electric Co.

2:00 p. m. Session on Selected Subjects

THEORY OF THERMAL BREAKDOWN OF SOLID DIELECTRICS, P. H. Moon, Massachusetts Institute of Technology

THE THREE-CIRCUIT TRANSFORMER, C. F. Estwick, General Railway Signal Co.

CORE-LOSS MEASUREMENTS AT HIGH-FLUX DENSITY, B. M. Smith and C. Concordia, General Electric Co.

EQUIVALENT CIRCUITS OF IMPERFECT CONDENSERS, C. L. Dawes and W. M. Goodhue, Harvard University

8:00 p. m. Informal reception—dancing and cards

Thursday, April 30

9:00 a. m. Symposium on Noise

THE MEASUREMENT OF NOISE IN ELECTRICAL MACHINERY, B. F. Bailey, University of Michigan

AN INDICATING METER FOR THE MEASUREMENT AND ANALYSIS OF NOISE, T. G. Castner, Bell Telephone Laboratories, E. Dietze and R. S. Tucker, American Telephone and Telegraph Co., and G. T. Stanton, Electrical Research Products, Inc.

THE MEASUREMENT OF MACHINERY NOISE, H. B. Marvin, General Electric Co.

INDUCTION REGULATOR NOISE, J. P. Foltz and W. B. Shirk, Westinghouse Electric & Mfg. Co.

MAGNETIC NOISE IN SYNCHRONOUS MACHINES, Q. Graham, P. Milliken, and S. Beckwith, Westinghouse Electric & Mfg. Co.

ELASTIC SUPPORTS FOR ISOLATING ROTATING MACHINERY, E. H. Hull and W. C. Stewart, General Electric Co.

NOISE MITIGATION IN SUBSTATIONS, E. A. Bishop, Commonwealth Edison Co.

12:00 m. District Executive Committee luncheon

2:00 p. m. Inspection trips:

Bausch and Lomb Optical Company
Stromberg-Carlson Telephone Mfg. Co.
Monroe Telephone Exchange
Kodak Park Works, Eastman Kodak Co.

2:00 p. m. Symposium on Noise—*continued*

Demonstration of Noise Measurement Apparatus

6:15 p. m. Joint Dinner Meeting of representatives of National Noise Study Committees of N.E.L.A., N.E.M.A., A.S.M.E., A.I.E.E. and other organization

7:30 p. m. Inspection of Eastman Theater and Eastman School of Music, including a performance

Friday, May 1

9:00 a. m. Student technical session

12:00 m. Student luncheon

2:00 p. m. Student inspection trips:

University of Rochester
Eastman Kodak Co.
Station 33, Rochester Gas & Electric Corp.

2:00 p. m. Symposium on Lightning

LIGHTNING, F. W. Peek, Jr., General Electric Co.

LIGHTNING DISCHARGES AND LINE PROTECTIVE MEASURES, R. N. Conwell, Public Service Electric & Gas Co., and C. L. Fortescue, Westinghouse Electric & Mfg. Co.

LIGHTNING INVESTIGATION ON THE 220-KV. SYSTEM OF THE PENNSYLVANIA POWER AND LIGHT CO., Edgar Bell and A. L. Price, Pennsylvania Power and Light Co.

1930 LIGHTNING INVESTIGATIONS ON THE TRANSMISSION SYSTEM OF THE AMERICAN GAS AND ELECTRIC COMPANY, Philip Sporn, American Gas and Electric Co., and W. L. Lloyd, Jr., General Electric Co.

LIGHTNING INVESTIGATION ON THE APPALACHIAN ELECTRIC POWER COMPANY'S TRANSMISSION SYSTEM, I. W. Gross, American Gas and Electric Co., and J. H. Cox, Westinghouse Electric & Mfg. Co.

EXPERIMENTAL STUDIES IN THE PROPAGATION OF LIGHTNING SURGES ON TRANSMISSION LINES, O. Brune and J. R. Eaton, Consumers Power Co.

LIGHTNING INVESTIGATION ON TRANSMISSION LINES—II, W. W. Lewis and C. M. Foust, General Electric Co.

6:30 p. m. Dinner; lecture, presentation of district prizes, and entertainment with dancing.

Saturday, May 2

8:30 a. m. Symposium on Lightning—*continued*

9:00 a. m. Inspection trips:

General Railway Signal Company
Station 9 of Rochester Gas and Electric Corp.
Coke Plant of Rochester Gas and Electric Corp.
University of Rochester
Niagara Falls

1931 Year-Book Now Available

The Institute's year-book for 1931, containing as usual a complete listing arranged both alphabetically and geographically of names and addresses of all members (correct to January 1, 1931), a copy of the by-laws and constitution, list of Institute officers and committees, as well as other information of interest in Institute activities, is now available for distribution.

On page 127 there will be found a paragraph requesting the earnest cooperation of all members to prevent the use of this year-book for advertising or circularizing purposes. Any such action must be considered as outside of its field of application, and as absolutely prohibited.

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Chemical Exposition To be Held in New York

The thirteenth exposition of Chemical Industries will be held at the Grand Central Palace, New York, during the week May 4-9, 1931.

The biennial exposition regularly includes not only exhibits from all of the forty or more industries classified as chemical, but also those from many others producing material or equipment used in chemical industries. Thus is offered an opportunity for studying a large array of equipment, and for comparing competitive products side by side.

Kodak Park—headquarters of the Eastman Kodak Co., one of Rochester's many nationally known industries

AN OPPORTUNITY for a delightful and useful summer trip is afforded by the choice of Lake Tahoe, California, as the scene of the Pacific Coast convention to be held August 25-29, 1931. Lake Tahoe is strategically situated—on a transcontinental main-line railroad, a mile high in the famous Sierra Nevada Mountains—and provides facilities that will make this a highly successful family convention. And the high-caliber technical program that rapidly is being completed will well justify an extra effort to attend.

All Engineers Welcome At International Congress, England

Anyone expecting to attend the 1931 International Illumination Congress opening at London September 2, 1931 (detail of which was published in the January Electrical Engineering, p. 59), should notify G. H. Stickney, secretary of the U. S. National Committee, Nela Park, Cleveland, Ohio.

Every endeavor is being made to keep the cost of travel as reasonable as possible; the conference is open to all interested in illumination in any of its branches, and the registration fee of £2 includes a copy of the proceedings of the congress; ladies exempt from all fees. A reception will be tendered by the civic authorities of each city in which the congress holds session.

A. S. A. Releases Refrigeration Safety Code

The American Standards Safety Code for Mechanical Refrigeration has just been published (February 1931) by the American Standards Association, 29 West 39th Street, New York, N. Y. The code which is sponsored by the American Society of Refrigerating Engineers, was approved by the American Standards Association in October 1930, and already has been adopted in its entirety by several cities; still others are considering its adoption. It represents one of the most important instances of the precaution necessary to prevent improper installation or use of technical equipment, already being taken by industry instead of its waiting to be forced into such action by public demand.

The booklet containing the safety code contains complete but concise information about the code and its advantages. It has been prepared as a reference manual for the use of any person or organization interested in its general adoption and use and it provides thoroughly practical and adequate regulatory measures for safe installation, operation, and inspection of mechanical refrigeration systems or units.

Washington Award Made to Ralph Modjeska

On February 25, 1931, before 360 members and guests of the five societies participating, Doctor Ralph Modjeska who in 1929 received the John Fritz Medal, highest American engineering award, had bestowed upon him the new honor of the Washington Award "for pre-eminent service in advancing human progress." Dr. Modjeska's history is too well known to require delineation here.

This award is administered by the Western Society of Engineers (Chicago) upon the recommendation of a commission representing the four founder societies; this year's ceremonies were at the Palmer House, Chicago, with Elmer T. Howson, chairman of the commission, presiding. Dr. Modjeska's acceptance was brief and was followed by a well-planned program at which Ralph Budd, president of the Great Northern Railway and principal speaker of the evening, gave an inspiring address upon the importance of the engineer's qualifying more fully to meet the economic problems bearing upon human progress.

Summer Convention At Asheville, N. C., June 22-26

The annual summer convention of the Institute will be held at Asheville, N. C., June 22-26, with headquarters at the Grove Park Inn.

Asheville, widely proclaimed by President Lee as the "land of the sky," is located in the highest part of the Blue Ridge Mountains, at an elevation of approximately 2,700 ft., and is counted one of the most scenic splendors of the South. Mt. Mitchell, rising to a height of 6,711 ft., and the highest peak east of the Rockies, is but a short distance away. The city's geographical location offers a splendid opportunity for members and their guests to visit such scenic points as Chimney Rock, Lake Lure, etc.

Seven technical sessions of broad scope and current interest have been scheduled tentatively as follows: automatic stations, symposium on system interconnection, cables, communication, instruments and measurements, electrical machinery, selected subjects, and research. The annual reports of technical committees, outlining advances in theory and practise of electrical activities in the various fields will also become available.

More complete details of this exceptional program will be announced in subsequent issues of Electrical Engineering.

Two Important Meetings at Birmingham

Birmingham (Ala.) the "largest city for its age in the world" will be possessed of a double importance when The American Society of Mechanical Engineers holds its semi-annual meeting there April 20-23,

1931, followed by an overlapping meeting of the American Electrochemical Society April 23-25. Headquarters for both of these meetings will be the Hotel Tutwiler, ideally situated in the "city beautiful" which lies among the foothills of the Appalachian Mountain group, with Red Mountain, Shades Mountain, the Mountain Brook Country Club, and the Birmingham Country Club all close at hand.

A system of electrification has been built up covering the state from Muscle Shoals to Mobile; a part of the attractive program arranged for the A. S. M. E. meeting will be devoted to the inspection of important industrial plants with generous allowance of time to be spent on hydroelectric installations—the Alabama Power Company's installation at Martin Dam, a reservoir of 40,000 acres furnishing 3,000,000 kw. storage, and Jordan Dam, the maximum head of which is 91 ft. Also there will be an interesting railroad session, one on power, another on safety, and still another on the handling of materials and machine shop practise, besides others devoted to subjects of more purely mechanical interests, each however with its quota of well-selected and carefully prepared subjects.

Astronomy and Electricity

As a fitting climax to one of the most successful years that the New York Section of the Institute has ever had, where the total attendance will exceed by 350 per cent that of the previous year, the officers of the Section have arranged an evening on "Astronomy and Electricity" to be held jointly with the New York Electrical Society in the Engineering Auditorium, 33 West 39th Street, New York, at 8:15 p. m. on Friday, April 24, 1931.

The speaker will be Dr. H. T. Stetson, director of the Perkins Observatory of Ohio Wesleyan University, Delaware, Ohio, which has the third largest telescope in the world. Dr. Stetson will outline clearly the results of recent investigation of the effects of solar activity on the earth's magnetism and on radio transmission. Sun spots and other astronomical phenomena will be dealt with in a manner understandable and entertaining to the engineer.

Preceding Dr. Stetson's talk, a description of the "Electrical Projection Planetarium" will be presented by Dr. Clyde Fisher of the American Museum of Natural History.

Both speakers are eminent in their respective fields and both talks will be profusely illustrated.

Annual Report Issued by United Engineering Trustees, Inc.

In calling attention to the availability of the annual report of United Engineering Trustees, Inc., a short historical outline may be of interest.

The United Engineering Trustees, Inc., which originally was called the United Engineering Society and then for a time Engineering Foundation, Inc., was incorporated in 1904 to administer the Engineering Societies Building, certain endowments, and other funds for its Founder Societies, the national societies of civil, mining, mechanical, and electrical engineers. Its objects—which are to maintain a free engineering library—to advance the engineering arts and sciences, to further research, are carried on through its three departments: The Engineering Societies Library, The Engineering Foundation, and the Administrative Department.

The three events of greatest significance in its history are the erection of the Engineering Societies Building at 29 West 39th Street, New York City (dedicated in 1907), the consolidation of the various society libraries in 1913 together with the establishment of the Library Endowment Fund by a gift from Dr. James Douglas of $100,000, and the creation of an engineering research foundation known as The Engineering Foundation, through the suggestion and generosity of Ambrose Swasey, whose gifts now total half a million dollars. The various funds over which the trustees now have supervision amount to $1,136,000.

In President Francis Lee Stuart's annual report for 1930 it is pointed out that the assets for which the corporation is responsible (real estate at cost, funds, and library as appraised) total $3,524,422.27. The development committee gathered data during the year on which to base an

SUMMARY OF 1930 FINANCIAL REPORT

Operation of Building		
Credit balance January 1, 1930		$12,290.66
Building revenue 1930	$133,170.65	
Building expenditures 1930	120,274.58	12,896.07
Total		$25,186.73
Annual payment to dep. and renewal fund	$12,000.00	
Reimbursement of general reserve fund	1,000.00	
Payment to reserve for future fire insurance	1,550.00	
		14,550.00
Credit balance December 31, 1930		$10,636.73
Operation of Library		
Maintenance revenue	$50,287.71	
Maintenance expenditures	48,046.69	
Credit balance for year 1930	2,241.02	
Credit balance from preceding years	3,447.93	
Total credit balance December 31, 1930		$ 5,688.95
Service bureau revenue	$21,559.89	
Service bureau expenditures and adjustments	20,842.18	
Credit balance for year 1930	717.71	
Credit balance from preceding years	4,016.25	
Total credit balance December 31, 1930		$ 4,733.96
Funds and Property		
Funds held by U. E. T. Inc., Dec. 31, 1930 (Book Value)		
Depreciation and renewal fund		283,734.79
General reserve fund		3,934.40
Engineering foundation fund		529,253.65
Henry R. Towne engineering fund		50,078.13
Library endowment fund		173,475.32
Edward Dean Adams fund		100,000.00
John Fritz Medal fund (Custodian)		3,500.00
Louvain Memorial fund		8,589.95
Total		$1,152,566.24
Real estate owned, cost to Dec. 31, 1930		1,987,793.92
Operating cash and petty cash		15,592.43
Accounts receivable		1,878.79
Value of library (as appraised for insurance)		358,544.00
Endowment committee loan receivable		1,700.00
Unexpired fire insurance premiums		3,297.09
Fire insurance fund (cash uninvested)		3,050.00
Total property which U. E. T. Inc. owns or holds		$3,524,422.47

estimate of the societies' needs for accommodations in the next ten years or more and a project for meeting those needs is under consideration. The Engineering Societies Building is reported in good condition but overcrowded.

In April, 1930 at the 50th anniversary of the American Society of Mechanical Engineers, a memorial tablet was placed in the entrance hall. The War Memorial to American Engineers in the Louvain Library continues to be of great interest to visitors to Belgium.

In passing to the summary of the financial report, it is worthy of note that all departments closed the year without deficits.

Engineering Foundation

Dielectric Research to Reveal Fundamental Properties

A study of the fundamental properties of dielectrics, a research conducted by Prof. J. B. Whitehead at The Johns Hopkins University, Baltimore, is part of a comprehensive program directed by the National Research Council's committee on electrical insulation.

During the year, the work on the research aided by Engineering Foundation has been mostly the design, construction, and installation of apparatus for exhaustive investigation of the dielectric properties of liquids, particularly insulating oils. The apparatus was successfully completed during 1930 and papers covering these researches are appearing from time to time in the publications of the A. I. E. E.

Welding Research Aided by Foundation

At the request of the A. I. E. E. the Engineering Foundation is aiding an investigation of pure iron electrodes to obtain basic data of use to electric welders.

This research is being conducted by Prof. Gilbert E. Doan under an agreement between the Foundation and Lehigh University. It was undertaken in June 1930 and progress has been made in designing and installing special apparatus and in developing methods.

Standards

Specifications for Dry Cells and Batteries

American standard specifications for dry cells and batteries have been issued recently as Circular No. 390 of the Bureau of Standards. These specifications prepared by the Bureau with the cooperation of manufacturers and users are a revision of the American standard of Feb. 27, 1928. The revision has been carried out concurrently by a technical committee of the Federal Specifications Board and the sectional committee of the A. S. A.; the two specifications are identical in substance, differing only in arrangement. Copies of Circular No. 390 may be obtained from the Superintendent of Documents, Washington, D. C., at a price of 5 cents per copy.

Weatherproof and Heat-Resisting Wire and Cable Specifications Approved

Two specifications developed by the sectional committee on insulated wires and cables came before the standards committee of the Institute on January 23, when they were approved by it; and subsequently by the board of directors on January 28, 1931. The specifications are as follows:

1. Weatherproof (weather-resisting) Wires and Cables: These specifications cover weatherproof wires and cables and the materials used for the braids and saturating compounds as applied to metallic conductors.

2. Heat-Resisting Wires and Cables: These cover the usual type of heat-resisting coating commonly known as "slow-burning," applied to metallic conductors for use in hot, dry locations where the standard insulating materials would not endure long or where the presence of large masses of inflammable materials would be objectionable.

Both of these specifications were developed by the committee acting under the procedure of the American Standards Association and the sponsorship of the A. I. E. E. and nine other bodies. They are now before A. S. A. for approval as American standards and upon the granting of such approval will be issued in pamphlet form by the Institute.

Specifications for Code Rubber Approved

A "Specification for Code Rubber Insulation for Wire and Cable for General Purposes" as developed by the sectional committee on insulated wires and cables, also was approved by the standards committee and subsequently (Jan. 28, 1931) by the board of directors. This specification will follow the same procedure as the two previously mentioned, and upon approval as an American standard will be issued by the Institute.

Revised Report on Proposed Lightning Arrester Standards

The protective devices committee of the Institute has just reported on a revision of the proposed "Standards for Lightning Arresters." The first report on this subject has been available since May 1928; the revision will be issued in pamphlet form replacing Report No. 28 of that date. Comments and criticisms are urgently requested and should be forwarded to Raymond Bailey, chairman A. I. E. E. protective devices committee, Philadelphia Electric Co., 900 Sansom St., Philadelphia, Pa. Copies of revised Report No. 28 may be had without charge by addressing H. E. Farrer, secretary standards committee, A. I. E. E., 33 West 39th St., New York, N. Y.

Personal

D. C. Prince has been appointed engineer of the switchgear department of the General Electric Company at Philadelphia. The appointment includes supervision of switchgear research activities at Schenectady. Mr. Prince has been with the General Electric since 1912, his work including the radio engineering department, the research laboratory and the switchgear department as research engineer. R. M. Spurck continues as assistant engineer with extended duties, and Chester Lichtenberg, assistant engineer since 1927, has been relieved of his duties to undertake a special assignment.

E. O. Shreve, assistant vice-president in charge of sales, General Electric Company, Schenectady, made a tour of its western offices last month, including those in Dallas, Houston, El Paso, Phoenix, Los Angeles, San Francisco,

Portland, Seattle, Spokane, Salt Lake, and Denver. In his capacity as a director in the American Management Association, he spoke before the Iron and Steel Conference, California State Chamber of Commerce, at Del Monte, Calif., and was the feature speaker at a meeting of the San Francisco Electrical Development League.

◆

Hadley F. Freeman of Cleveland associating himself with G. M. Albrecht, former examiner in the United States Patent Office has opened offices under the company name of Freeman and Albrecht, Patent Attorneys, at 807 Mariner Tower, Milwaukee, Wisconsin. Mr. Freeman is a member of the firm of Smith and Freeman, Patent Attorneys, Cleveland, and of Freeman and Sweet, Patent Attorneys, Chicago; both will be represented by the new firm.

◆

H. C. Leonard, who was elected president of the Electrical League of El Paso (Texas) at a recent meeting, has been known to the electrical fraternity of El Paso for less than a year. He came to the western city last summer to take over the duties of general superintendent of the El Paso Electric Company, succeeding W. R. Bell, who was transferred to other Stone & Webster properties at Baton Rouge, La.

◆

Frank J. Airey, division manager of the General Electric Supply Corporation at Los Angeles, was elected chairman of the Pacific Division, National Electric Wholesalers' Association, at the annual meeting of the organization at Del Monte, Calif. He has been in the electrical merchandizing business more than 42 years, having occupied the various positions of salesman, sales manager, division manager and general manager.

◆

W. H. Lesser has been appointed combustion and mechanical engineer of the newly organized Penn Anthracite Collieries Company, Scranton, Pa. Mr. Lesser has wide practical experience in the preparation, utilization, and distribution of anthracite. As a member of the American Institute of Electrical Engineers he has served as chairman of the Committee on Applications to Mining Work.

D. W. Proebstel, for many years test engineer for the Portland General Electric Company, Portland, Ore., and its predecessors, has been promoted to the engineering department of the parent company, Central Public Service Corporation, Chicago. In his new position Mr. Proebstel will be assistant in electrical engineering to L. N. Boysen, who is assistant to the operating vice-president.

◆

J. B. MacNeill Now Distribution Manager

J. B. MacNeill, who has held successively the positions of circuit-breaker engineer, section leader on circuit breakers, and manager of the circuit-breaker engineering department of Westinghouse

J. B. MacNEILL

Electric and Manufacturing Company, has now received a new appointment as general manager of distribution engineering with headquarters at East Pittsburgh. This group comprises the engineering activities of switchboards, circuit breakers, meters, relays, high-voltage insulators, and lightning arresters. Improvements in modern switching equipment including the development of deion circuit breakers has been carried out under Mr. MacNeill's direction. He is a member of the National Electrical Manufacturers Association, and spent the summer of 1930 reviewing European practise on switchgear and distribution apparatus, after attending the World Power Conference at Berlin as a representative of NEMA.

◆

Albert M. Jacobs has been elected president of the South African Institute of Electrical Engineers for the current year. For the past five years he has been a member of the board and chief technical offices of the Electricity Supply Commission in the Union of South Africa.

Charles F. Ruffner has resigned as a vice-president of the Niagara-Hudson Power Company, but continues as chairman of the board and a director of the New York Power & Light Corporation.

◆

Thomas S. Wood, electrical manufacturers' agent, Seattle, recently attended the annual convention of the Sangamo Electric Company at Springfield, Ill.

◆

S. R. Inch, a vice-president of the Electric Bond & Share Company, has been elected executive vice-president.

◆

T. S. Perkins Named Merchandising Manager

T. S. Perkins has been chosen to head the new "merchandising department" of Westinghouse Electric and Manufacturing Company, East Pittsburgh, and will become executive of these new engineering activities with the title of general manager of merchandising engineering. In this position he will represent S. M. Kintner, assistant vice-president, in work of supply, appliance, refrigeration, and illuminating engineering departments. Mr. Perkins joined the Westinghouse organization immediately after his graduation from Worcester Polytechnic Institute in 1893 and has been with that company continuously since that time. For six years he

T. S. PERKINS

has been a member of the Irwin (Pa.) Borough Council and president of that body for two years. He also has served as vice-president of the Westmoreland County Council, Boy Scouts of America; he was one of the organizers of the Irwin Saving and Trust Company, of which he is one of the directors, and is a past-president of the Irwin Chamber of Commerce.

Obituary

A. H. Crossman, sales engineer for the Pacific Electric Mfg. Corp., San Francisco, California, and an Associate of the Institute since 1928, died at his home, Burlingame, Calif., February 8, 1931. A native of Cambridge, Mass., Mr. Crossman obtained his A. B. from Bowdoin College, Brunswick, Maine, in 1916 and his B. S. degree from M. I. T. in 1923, specializing in Economics at the first mentioned college and in hydroelectric engineering at M. I. T. In three years, from 1917 to 1920, he rose from second lieutenant to captain's rank in the Coast Artillery Corps, U. S. Army; three years later he joined the Southern Sierra Power Company at Riverside, Calif., embracing a student course which it was offering and advancing from Engineer in the distribution department to sales engineer, his last office.

H. M. Walmsley, a Member of the Institute since 1921, died January 5 at Christ Hospital, Cincinnati, Ohio, following an operation for appendicitis. He had been in the electrical engineering field ever since 1905, when he took the G. E. Test Course at Schenectady immediately following graduation from Purdue University. He was born in Chicago, and his first work after completion of the Test Course was with the operating and construction departments of the Commonwealth Edison Company. From Chicago he went to Canton, Ohio, as resident engineer for Sargent and Lundy and the American Gas and Electric Company and also the Canton Electric Company. In the interests of the first two companies, he went to West Virginia to care for the erection of a new 10,000-kw. station for the Wheeling Electric Company. This was in 1913, and the following year he represented these same firms in the work of a new power station for the Ohio Light and Power Company, at Newark, Ohio. A $7,000,000 station and distribution system for the Cincinnati Gas and Electric Company was another product of his executive ability, as were the stations of the Kansas City Light and Power Company, the Public Service Company of Oklahoma, and the power and ice-plant of the Albilene Light, Water and Gas Company, Albilene, Texas. Mr. Walmsley was a member also of the American Society of Mechanical Engineers.

Harry J. Hunsicker, electrical engineer of the New York Power and Light Corporation, Albany, died suddenly March 6th of acute dilation of the heart. He was born at Lehighton, Pa. July 5, 1879, and since 1907 had been an Associate of the Institute. His B. S. in E. E. was conferred upon him when he graduated from the Pennsylvania State College in 1901, and in July of that same year he entered the testing department of the General Electric Company at Schenectady. In August 1903 he joined the Hudson River Electric Power Company, first on electrical construction work, but rising shortly to the office of assistant electrical engineer. Mr. Hunsicker was active in building the Spier Falls hydraulic project, one of the important developments of the section in which he has spent most of his professional life.

V. O. Chewning, assistant electrical engineer of the Illinois Terminal Railroad System, died February 15, 1931, in the Barnes Hospital, St. Louis, Mo. Mr. Chewning was born at Taylorville, Ill., in 1892; he served two years overseas during the World War and for three years was employed as local manager for the Central Illinois Public Service Company at Charleston, Illinois. Ten years ago he joined the Illinois Terminal Railway System, where his services were principally on the construction, maintenance and operation of railway substations. For a year and a half he was chief power dispatcher for the company at Taylorville, Illinois. He joined the Institute as an Associate in 1922.

Addresses Wanted

A list of members whose mail has been returned by the postal authorities is given below, with the addresses as they now appear on the Institute records. Any member knowing of corrections to these addresses will kindly communicate them at once to the office of the secretary at 33 West 39t S., New York, N. Y.

Davis, R. H., Westinghouse E. & M. Co., East Pittsburgh, Pa.

Dawson, Leonard L., 98 Looker Ave., Springfield, N. J.

DiLucci, A., Box 1051, Chicago, Ill.

Duane, George B., Otis Elevator Co., Yonkers, N. Y.

Gale, R. E., 706 N. 19th St., Boise, Idaho.

Kigar, D. F., 1403 Minnie St., Port Huron, Mich.

Muncy, V. E., Ohio Mechanics Institute, Cincinnati, Ohio.

Nichols, F. A., 301 Belmont Apts., Seattle, Wash.

Prehn, Victor N., 940 Broad St., Newark, N. J.

Sherwood, W. E., Kew Gardens, 2700 Que St. N. W., Washington, D. C.

Sliney, David, 11 Orchard St., Cranford, N. J.

Van Wyck, P. V. R., Summit, N. J.

Local Meetings

Joint Meeting Held in Virginia

A joint meeting of the local Sections of the A. S. C. E., A. S. M. E., and A. I. E. E. and the Engineers Club of Hampton Roads was held at the Southland Hotel, Norfolk, January 30-31, 1931, with an attendance of 94. The program was as follows:

Friday Morning

F. F. Harrington, chairman, Virginia State Section, A. S. C. E., presiding.

Industrial Heating, by M. K. Clark, York Heating and Ventilating Corp.

The Fair of the Iron Horse—A moving picture. Business sessions of State Sections.

Luncheon

Charles W. Johnston, president, Engineers Club of Hampton Roads, presiding.

Welcoming Address, by Hon. E. Jeff Robertson, Mayor of Norfolk.

The North Atlantic Ice Patrol, by Captain William J. Wheeler, U. S. Coast Guard, with moving picture film.

Weather Predicting, by C. H. Richardson, meteorologist, U. S. Weather Bureau, Norfolk, Va.

Friday Afternoon

Motor bus excursion to Little Creek Terminal, Penn. R. R.; Cape Henry, Va.; Fort Story, (harbor defenses of Chesapeake Bay); and Virginia Beach.

Friday Evening

Dinner at Pine Tree Inn, Virginia Beach, J. H. Berry, chairman, Southern Virginia Section, A. I. E. E. presiding.

Technological Unemployment, by Professor Dexter S. Kimball, dean of the College of Engineering, Cornell University.

Electricity—Past, Present, and Future, by C. M. Ripley, General Electric Co.

Saturday

Golf; special visits to Navy Yard, Naval Base, and other places of interest.

At the business meeting of the A. I. E. E. Section the following officers were elected to take office February 1, 1931: J. H. Berry, Chairman; E. L. Lockwood, Secretary-Treasurer; E. S. Fitz and S. C. Foster, Executive Committee.

Branches Organized at U. of Illinois and Rice Institute

The formation of Student Branches of the Institute at the University of Illinois and at Rice Institute was authorized by the Board of Directors at its meeting held on January 28, 1931. Both groups have completed their organization, and the following officers are in charge:

University of Illinois: W. P. Burgland, president; F. M. Deerhake, vice-president; G. L. Bodwell, secretary; R. R. Wood, treasurer.

Rice Institute: A. R. Edwards, president; D. B. Good, vice-president; M. E. Kattmann, secretary; K. Beyette, treasurer; A. M. Wittmann, executive committee member.

Future Section Meetings

Cleveland

April 16, 1931—Human Relations in Industry, by Whiting Williams. Joint meeting with Student Branch of Case School of Applied Science, at which two papers will be presented by students.

May 21, 1931—Annual dinner meeting. Speaker—W. S. Lee, vice-president and consulting engineer, Duke Power Company, and president, American Institute of Electrical Engineers.

Detroit-Ann Arbor

April 21, 1931—1000-Deg. Turbine, by Paul W. Thompson, Detroit Edison Co. Meeting to be held at the Detroit Edison Auditorium.

May 19, 1931—Subject and speaker to be announced later.

Lehigh Valley

April 24, 1931—Ladies' Night, to be held at Americus Hotel, Allentown, Pa.

May 16, 1931—Annual Meeting. System Development, by E. C. Stone, assistant to senior vice-president, The Philadelphia Company. Meeting to be held at Altamont Hotel, Hazleton, Pa.

Niagara Frontier

April 17, 1931—Art of Engineering, by Mr. Dohner, Westinghouse Electric & Mfg. Co.

May 15, 1931—Subject and speaker to be announced later.

Seattle

April 21, 1931—Annual joint meeting with the A. I. E. E. Student Branch of the University of Washington. Program under the auspices of the students.

May 19, 1931—The best paper submitted in the annual competition for prizes will be presented at this meeting.

Sharon

May 5, 1931—The Contributions of Telephone Research to the Talking Motion Picture Industry, by J. O. Perrine, Associate Editor, *Bell System Technical Journal.*

Spokane

April 24, 1931—Joint meeting with the Student Branches of The State College of Washington and University of Idaho. Papers by local members and students. Meeting to be held at Pullman, Wash.

May 22, 1931—Annual Dinner Meeting. History of the Electrical Development of the Inland Empire, by John B. Fisken. Election of officers.

Toledo

April 17, 1931—High Lights in the Glass Industry, by A. H. Stebbins, Libbey Ford Glass Co. Storage Batteries, by W. E. Dunn, Electric Storage Battery Co.

May 22, 1931—Speakers—T. J. Nolan, Toledo Edison Co. and J. T. Greene, Police and Fire Alarm System.

Past Section Meetings

Akron

Electronic Tubes and Their Applications, by H. P. Sparkes, Westinghouse Electric & Mfg. Co. Demonstrations. February 12. Attendance 150.

Atlanta

Speed, Unemployment and Progress, by Dr. William McClellan, vice-president, Stone & Webster Engineering Corp. Dinner preceded the meeting. February 27. Attendance 73.

Baltimore

Marvels of Sound Transmission, by S. P. Grace, assistant vice-president, Bell Telephone Laboratories, Inc. Demonstrations. Meeting held jointly with all engineering societies of Baltimore and the Association of Commerce. Dinner in honor of the speaker preceded the meeting. January 16. Attendance 1,700.

Municipal Rapid Transit Subways of New York City, by Robert Ridgway, chief engineer, Board of Transportation of New York City. Illustrated. Joint meeting of the local engineering societies, sponsored by the A. S. C. E. February 4. Attendance 120.

The proposed bill for the Registration of Engineers in the State of Maryland was discussed by the following speakers: Henry G. Perring, S. S. Steinberg, W. B. D. Penniman, W. B. Kouwenhoven F. T. Leilich, E. D. Edmonston, A. L. Penniman, and others. After considerable discussion a resolution was unanimously adopted stating that the enactment of the registration law in the Maryland Free State was neither desirable nor beneficial to either the public or the members of the engineering profession. February 17. Attendance 200.

Lightning Research, by Edward W. Beck, Westinghouse Electric & Mfg. Co. Mr. Beck presented a résumé of the lightning researches carried out in Tennessee and New Jersey, and showed numerous slides illustrating experiments with the auto-valve arrester that have been performed on transmission lines. February 20. Attendance 78.

Cincinnati

Television: Its Physical, Psychological, and Fundamental Principles, by Dr. J. O. Perrine, associate editor, *Bell System Technical Journal.* Demonstration of the use of the scanning disk and photoelectric cell. January 15. Attendance 570.

Some New and Interesting Developments in Engineering and Research, by A. M. Dudley, Westinghouse Electric & Mfg. Co. February 12. Attendance 98.

Cleveland

The Flying Telephone, by F. M. Ryan, Bell Telephone Laboratories, Inc. The development work which was necessary before actually designing telephone equipment for aeronautical purposes was explained and illustrated. February 19. Attendance 176.

Columbus

Recent Advances in Aircraft Communication, by F. M. Ryan, Bell Telephone Laboratories, Inc. Illustrated by lantern slides and a Western Electric sound picture "The Flying Telephone;" also, an exhibition of the types of apparatus employed in aviation radio installations. February 20. Attendance 135.

Connecticut

Glass Insulation, by Wm. W. Shaver, Corning Glass Works. Slides and moving pictures were presented illustrating the manufacture of glass, methods of handling

and moulding glass, and the comparative tests of glass insulators with porcelain insulators. February 11. Attendance 63.

Dallas

St. Louis-Dallas Underground Toll Cable, by C. W. Nystrom, Southwestern Bell Telephone Co. Illustrated with films and slides. January 19. Attendance 106.

Lighting the Home, by Miss Ethel Hudson, Dallas Power & Light Co. Illustrated with slides. Joint meeting with Illuminating Engineering Society. February 16. Attendance 94.

Denver

Radiation, by Paul Luckenbach, General Electric Company. Joint meeting with the A. S. M. E., A. C. S., Colorado Scientific Society, and Teknik Club. February 6. Attendance 160.

Detroit-Ann Arbor

Electric Power Cables, by G. B. McCabe, Detroit Edison Co., and L. F. Hickernell, Allied Engineers, Inc. This subject was divided into two parts; Mr. McCabe outlined the manufacture, construction, installation, operation, and recent improvements in design, and Mr. Hickernell spoke on the application and specifications. Slides were used to illustrate the design and use of many kinds of cable. January 20. Attendance 200.

The Detroit Toll Board, by E. C. Balch, Michigan Bell Telephone Co. Preceding this meeting, there was an inspection trip through the Detroit Toll Board. February 17. Attendance 200.

Indianapolis-Lafayette

The Deion Breaker, by B. P. Baker, Westinghouse Electric & Mfg. Co. Mr. Baker discussed the theory underlying the construction and uses of the Deion air breaker and Deion grid breaker. Illustrated. February 20. Attendance 62.

Iowa

Electric Eye, Stroboscope, and Televox, by H. B. Stevens, Westinghouse Elec. & Mfg. Co. Apparatus was used to demonstrate the use of the Electric Eye and Televox. Joint meeting with the Iowa State College Branch. February 6. Attendance 339.

Ithaca

Outdoor Lighting, by E. H. Powell, General Electric Co. February 20. Attendance 35.

Lehigh Valley

Recent Developments in Generation and Transmission of Electric Power, by R. C. Bergvall, Westinghouse Electric & Mfg. Co. Outline of recent developments in electrical equipment to promote system stability under faulty or abnormal conditions. Meeting held at Hotel Casey, Scranton, Pa. February 4. Attendance 93.

The Future of Vacuum Tubes, by Dr. Albert W. Hull, General Electric Co. Joint meeting with the Engineers Club, held at Hotel Easton, Easton, Pa. February 27. Attendance 175.

Los Angeles

Dynamic Power Limits of Transmission Systems, by Wm. S. Peterson, Los Angeles Bureau of Power & Light. Mr. Peterson used the Griscom Mechanical Devices for illustrating stability problems, and also used a number of slides showing methods of calculation. Discussion followed. February 17. Attendance 76.

Louisville

Speed, Unemployment, and Progress, by Dr. William McClellan, vice-president, Stone & Webster Engg. Corp. February 20. Attendance 52.

Madison

Joint meeting with the University of Wisconsin Branch, at which the following papers were presented by students:

Automatic Oscillographs, by J. D. Cobine;

Trends in Electrical Construction, by R. J. Nickles, Jr.;

Copper-Oxide Rectifiers, by John L. Jones. February 18. Attendance 55.

Memphis

The Operation of the Distribution System of the Memphis Power & Light Co., by H. E. H. Martin, chief dispatcher, and W. A. Gentry, supt. of Distribution Operation Dept. of the above company. Two films entitled "Voltage Regulators," and "Oil Circuit Breakers." February 10. Attendance 34.

Speed, Unemployment, and Progress, by Dr. William McClellan, vice-president, Stone & Webster Engg. Corp., March 9. Attendance 84.

Minnesota

Electrification of the Cascade Tunnel, by J. E. Hawe, Great Northern Railway Co. Illustrated with moving pictures. March 4. Attendance 100.

Niagara Frontier

Interruption of High Currents at Low Voltages, and Application of Research to Development of Low-Voltage Air Circuit Breakers, by Knute Falck, I. T. E. Circuit Breaker Co. Illustrated. Film—"Building New York's Newest Subway." Dinner in honor of the speaker at the Hotel Niagara. February 20. Attendance 70.

Oklahoma City

Inductive Coordination of Communication and Electric Supply Equipment, by E. B. Jennings, Southwestern Bell Telephone Co., and C. E. Bathe, Oklahoma Gas & Electric Co. Dinner preceded the meeting. January 26. Attendance 54.

Recent Technical Developments in the Electrical Industry, by I. T. Monseth, Westinghouse Elec. & Mfg. Co. Illustrated with a number of pictures of developments made by the above company during the past year. February 23. Attendance 60.

Philadelphia

Some Developments and Applications in Electrical Communications, by R. D. Parker, American Tel. & Tel. Co. March 9. Attendance 225.

Pittsburgh

Research By-Products, by Dr. Phillips Thomas, Westinghouse Elec. & Mfg. Co. Mr. Thomas described and demonstrated a number of unusual applications of photo- and grid-glow tubes and other electronic devices. Joint meeting with I. R. E. and Engineers Society of Western Pennsylvania. February 9. Attendance 236.

Pittsfield

Color Photography, by Glenn E. Mathews, Eastman Kodak Co. Illustrated with slides and movies. February 17. Attendance 400.

River of Mystery—The Orinoco, by Dr. Herbert S. Dickey, Explorer and Scientist, Museum of the American Indian. Dinner preceded the meeting. March 3. Attendance 900.

Portland

Joint dinner meeting with the Oregon State College Branch, at which the following papers were presented by students:

The Characteristics of Pentode Tubes, by N. G. Reetz;

A High Voltage Corona Rectifier, by D. C. Foster and Wm. R. Bullis;

A Per Cent Registration Calculator for Watthour Meters, by C. E. Boucher. February 30. Attendance 85.

Artificially Generated Sun Light, by Paul Luckenbach, General Electric Co. Illustrated with lantern slides. March 3. Attendance 140.

Rochester

Materials Handling, by C. B. Crockett, Industrial Truck Association. Mr. Crockett stressed the importance of scientific handling of materials in large industrial plants and its cost and effect on production. Joint meeting with the I. R. E., A. S. M. E., R. E. S. October 9. Attendance 89.

The Advantages of Increased Power for Clear Channel Broadcasting Stations, by O. H. Caldwell, editor of *Electronics*;

Extending the Radio Frequency Spectrum, by A. H. Taylor, director, Naval Research Laboratories. Joint meeting with the I. R. E. November 21. Attendance 231.

Recent Achievements in Electrical and Steam Generation, by E. M.

Gilbert, W. S. Barstow & Co. Joint meeting with the I. R. E., A. S. M. E., and R. E. S. January 8. Attendance 208.

The Story of Commercial Enameling, by James H. Snyder, Pfaudler Co. Mr. Snyder described the difference between glass and paint enameled goods and demonstrated the Pfaudler method of mixing glass enamel. Joint meeting with the I. R. E., A. S. M. E., and R. E. S. January 22. Attendance 83.

Communism in the Abstract, by Colonel Hugh L. Cooper. Slides were used to illustrate the various engineering projects which Colonel Cooper has undertaken in Russia, and particularly the construction of the dam on the Dnieper River. Joint meeting with the I. R. E., A. S. M. E., and R. E. S. February 5. Attendance 416.

Making of Radio Tubes, by Paul T. Weeks, Raytheon Production Corp. Mr. Weeks analyzed the manufacturing end of the radio tube industry explaining, by the use of slides, the entire process from the manufacture of the elements to the finished tube assembly. Joint meeting with the I. R. E., A. S. M. E., and R. E. S. February 12. Attendance 77.

Transoceanic Telephony, by Henry Nicholson, Lyddon, Hanford & Kimball Co. Luncheon with the I. R. E., A. S. M. E., and R. E. S. sponsored by the A. I. E. E. January 6. Attendance 43.

What Can Retraining Do for Unemployment, by John A. Randall, president, Mechanics Institute. Luncheon with the I. R. E., A. S. M. E., and R. E. S., sponsored by the A. I. E. E. January 13. Attendance 50.

One Year's Progress in City Manager Government, by Stephen B. Story, city manager. Luncheon with the I. R. E., A. S. M. E., R. E. S., sponsored by the A. I. E. E. January 20. Attendance 66.

Telephone Traffic in Rochester, by John P. Boylan, Rochester Telephone Corp. Luncheon with the A. S. M. E., I. R. E., and R. E. S. January 27. Attendance 66.

St. Louis

Modern Developments in Large Waterwheel Generators and Synchronous Condensers, by Marvin W. Smith, Westinghouse Electric & Mfg. Co. Illustrated with slides. February 18. Attendance 85.

San Antonio

A. E. Allen, General Electric Co., discussed some of the recent developments of the electrical industry. Films were shown entitled "The Trend in Turbine Design," and "The Trackless Trolley Bus." February 16. Attendance 62.

Speed, Unemployment, and Progress, by Dr. William McClellan, vice-president, Stone & Webster Engg. Corp. March 4. Attendance 92.

Schenectady

Vacuum Tubes in Electrical Engineering, by W. C. White, General Electric Co. Illustrated with demonstrations. January 16. Attendance 200.

The World Background of American Business, by Charles A. Eaton, Member of Congress from New Jersey, and Member of the House Foreign Affairs Committee. February 6. Attendance 75.

The Manufacture of Iron and Steel, by G. A. Richardson, Bethlehem Steel Co. Moving pictures showing in detail the manufacturing methods in use in the steel industry were presented. February 20. Attendance 260.

Sharon

Recent Interesting Aeronautical Developments, by Samuel P. Mills, N. Y. University. Illustrated with slides and film entitled "Mexico." March 3. Attendance 227.

Spokane

A Résumé of Recent Developments in Predetermination of System Performance, by Dean H. V. Carpenter, State College of Washington. Discussion followed. February 27. Attendance 20.

Toledo

The Flying Telephone, by F. M. Ryan, Bell Telephone Laboratories, Inc. Illustrated with lantern slides, motion pictures, and demonstrations. February 17. Attendance 350.

A New Combustion Indicator, by Max Neuber, Motormeter Gauge & Equipment Co.;

Vacuum Treatment of Insulating Oils, by R. P. Dunmire, Buckeye Laboratories, Inc. March 6. Attendance 60.

Toronto

Applied Psychology, by Prof. S. N. F. Chant, University of Toronto. Considerable discussion followed this talk. Joint meeting with the Engineering Institute of Canada. February 12. Attendance 180.

Operation and Maintenance of Generating Stations, by A. S. Robertson, Hydro-Electric Power Commission. Illustrated with slides. February 27. Attendance 132.

Urbana

Lighting Architecture, by H. S. Logan, Holophane Co. Illustrated with slides and film entitled "Making Mazda Lamps." February 18. Attendance 120.

Utah

Television, by S. W. Pixton, Mountain States Tel. & Tel. Co. Mr. Pixton gave an illustrated lecture upon the history and developments of television, particularly from the standpoint of the Telephone Co. Informal dinner preceded the meeting. February 16. Attendance 80.

Vancouver

Joint meeting with the University of British Columbia Branch, at which the following papers were presented by students;

Manually-Operated Telephone Exchanges, by J. W. Smith;

Incandescent Lamps, by D. Smith;

Mercury Arc Rectifiers, by M. A. Thomas. March 2. Attendance 50.

Washington

Television, Its Fundamental, Physical and Psychological Principles, by Dr. J. O. Perrine, associate editor, *Bell System Technical Journal*, Dr. Perrine demonstrated the photoelectric cell and neon lamp. March 10. Attendance 260.

Worcester

Power Factor and Its Relation to Induction Motor Applications, by Prof. H. A. Maxfield, Worcester Polytechnic Institute. February 25. Attendance 30.

Past Branch Meetings

University of Akron

Underground Power Distribution Systems, by G. E. Buffington, student. Frank Marcinkoski, student, gave a demonstration of shock resuscitation. February 26. Attendance 10.

Alabama Polytechnic Institute

Detecting Rail Fissures, by J. M. Johnson, student. Mr. Jager, student, gave a description of his summer work as a mechanic in the mines. February 12. Attendance 15.

University of Alabama

Methods of Breaking Arcs, by Prof. F. R. Maxwell, Jr., counselor;

Electric Welding, by C. Hendrickson, student;

Pile Bridges, by W. G. Gable, student. December 15. Attendance 8.

Layout of Anniston Primary Substation, by Paul Clark, student;

Attention Paid to Safety by Large Companies, by W. H. Croft, student. January 12. Attendance 7.

Power Rates, by W. G. Gable, student;

Synchronous Condensers, by Paul Clark, student;

Electric Railways, by C. Hendrickson, student. January 26. Attendance 10.

Electrical Engineering in Aviation, by Prof. Leslie Walker. February 9. Attendance 8.

Business meeting. February 23. Attendance 8.

Professional Relationships, by Dr. Benjamin A. Wooten, head, Physics Dept.;

Opportunities in the A. I. E. E., by Prof. Fred R. Maxwell, Jr., counselor. February 27. Attendance 43.

University of Arkansas

Discussion of plans for Engineers' Day. February 18. Attendance 22.

Armour Institute of Technology

Asbestos Insulated Wire and Cable, by William Tierney, Rockbestos Products Corp. February 20. Attendance 52.

Talking Motion Pictures, by H. Merrill Smith, Electrical Research Products, Inc. March 6. Attendance 60.

University of British Columbia

Joint meeting with the Vancouver Section at which three papers were presented by students. (See report under "Past Section Meetings.")

Polytechnic Institute of Brooklyn

A-C. Distribution, by James G. Grover, student;

The Trend in A-C. Transmission, by Frank Powers, student;

Cathode Ray Oscillograph, by R. G. O'Sullivan, student. Frank Powers was awarded first prize and Robert G. O'Sullivan second prize. February 17. Attendance 18.

The Advantages Gained by the Young Engineer who Joins a Technical Society, by Roy V. Wright, president A. S. M. E. Joint meeting of the four technical societies. February 19.

Michael Faraday, by Leon Danner, student;

X-Ray Crystallography, by Sam Siegel, student;

A New Method of Scanning for Television, by Ivan Block, student. Ivan Block won first prize and Sam Siegel second prize. March 2. Attendance 25.

California Institute of Technology

L. H. Means, General Electric Co., outlined the problems met by industry in dealing with its operating personnel. He also gave a brief description of the General Electric Co. and its policies and practises toward employees. February 17. Attendance 52.

University of California

Initiation banquet at which the following papers were presented:

Why I Joined the A. I. E. E., by J. J. Cassidy, Jr., student;

Latest Developments in Electrical Engineering, by P. B. Garrett, Westinghouse Electric & Mfg. Co., and chairman San Francisco Section, A. I. E. E. February 3. Attendance 50.

New Developments in Toll Transmission, by C. V. Fowler, Pacific Tel. & Tel. Co. February 25. Attendance 38.

Case School of Applied Science

Electrical Knowledge of Faraday's Time, by Dr. W. E. Wickenden, president, Case School of Applied Science;

Faraday's Contributions to Science, by A. Friedman, student;

Faraday, the Man and His Life, by K. Spangenberg, student. Dinner meeting. March 3. Attendance 60.

Clemson Agricultural College

Life of Steinmetz, by C. V. Rentz, student;

75-Kv. Submarine Cable, by C. J. Davenport, student;

Miniature Switchboards, by L. W. Foster, student;

Radio Telephone Service to Ships at Sea, by C. DuRant, student;

Current events discussed by H. S. Montgomery. January 8. Attendance 24.

Life of Watt, by J. P. Littlejohn, student;

Football Field Illumination, by A. B. Coggins, student;

Current events discussed by G. H. Epting, student. January 22. Attendance 20.

Colorado State Agricultural College

Business meeting. February 9. Attendance 12.

The Application of Electricity in the Rayon Industry, by Prof. D. Bachelder. January 28. Attendance 13.

University of Colorado

Federal Regulation of Radio, by G. W. Earnhart, asst. radio inspector, Radio Commission. February 18. Attendance 58.

Carrier-Current Pilot of the Vincent 220-Kv. Transmission Line of the Southern California Edison Co. Ltd., by F. B. Doolittle, Southern California Edison Co., Ltd. February 23. Attendance 70.

An Explanation and Demonstration of Photophone Equipment, by A. S. Anderson, General Electric Co. Films—"The Electric Ship," "A Trip Through the Cascade Tunnel," and "Radio Active Rays." March 4. Attendance 325.

Cooper Union

Symposium on Electro-optics, by A. Ginsberg, D. Briansky, and G. Kosolopoff, students. Illustrated by experiments. March 4. Attendance 32.

Cornell University

Electricity in Railway Transportation, by R. R. Brainard, Branch secretary;

Trolley Buses, by O. K. Williams, student;

A Canadian Canoe Trip, by R. E. Nelson, student. February 18. Attendance 16.

University of Denver

Railway Electrification, by Frank Nutt, student. January 13. Attendance 24.

Film—"Building New York's Newest Subway." January 27. Attendance 33.

Photometers, by Louis Duval, student;

Hunting of Synchronous Machines, by F. W. Olmsted, Branch secretary. February 3. Attendance 21.

Film—"On the Pathways of Progress." February 10. Attendance 25.

High- and Low-Frequency Oscillators, by G. H. Lovins, student. February 17. Attendance 15.

University of Detroit

Inspection trip to the Del Ray power house and the Waterman substation of the Detroit Edison Co. January 15. Attendance 40.

Television, by H. Folkrod, Michigan Bell Telephone Co. Film—"History of Wireless." February 12. Attendance 75.

Drexel Institute

My Work in the Lightning Laboratory of the Pennsylvania Power & Light Co., by H. C. Werner, student. February 10. Attendance 18.

Philadelphia Electric's Present Transmission System, by W. W. Woodruf, Philadelphia Electric Co. March 3. Attendance 34.

University of Florida

The History and Development of Short-Wave Transmission in Radio, by R. E. Herrick, student;

The Construction of Audio Transformers, by R. M. Weinkle, student. March 9. Attendance 38.

Georgia School of Technology

Film—"The Single Ridge." February 11. Attendance 95.

Harvard University

Corrective Research, by F. V. Weeks, student;

A Summer with Westinghouse, by C. W. Waldow, student;

Between Students, by J. L. Beaver, student. March 4. Attendance 17.

University of Idaho

Film—"Construction of Wire." January 28. Attendance 63.

Two talks by students. February 3. Attendance 35.

Film—"Wizardry of Wireless." February 4. Attendance 55.

Time Pieces, by Glenn Gage, student. Talk by Professor J. H. Johnson, counselor. February 17. Attendance 37.

Motor Characteristics, by H. L. Vincent, General Electric Co. March 3. Attendance 37.

Kansas State College

H. M. Lowe, who recently returned from three years' work in South America

related his experiences while there. Election of officers. February 5. Attendance 105.

University of Kansas

Howard Sutton, student, gave a technical report on a Westinghouse Relay for the control of transformers in parallel, after which he presented the relay to the electrical department for research work.

Rectification of Alternating Current Waves, by B. Brown, student. February 26. Attendance 45.

University of Kentucky

Inspection trip through the local telephone exchange. March 5. Attendance 41.

Lafayette College

Business meeting. March 7. Attendance 17.

University of Louisville

The Life of Edison, by E. B. Wagner, student;

Deion Circuit Breakers, by C. R. Best, student. Illustrated. February 13. Attendance 21.

Marquette University

Debate between Mr. Horowitz and H. Jessell, students, on Coeducation at Marquette. Mr. Harriss of South Africa related living conditions in his home land. Joint meeting with the A. S. C. E. and A. S. M. E. Branches. December 18. Attendance 49.

Welding Generators—Their Construction and Applications, by K. L. Hansen, Northwestern Manufacturing Co. Joint meeting with the School of Engineering of Milwaukee Branch. January 7. Attendance 21.

Massachusetts Institute of Technology

Illumination and Color, by K. J. Germeshausen, student;

Broadcasting Development, by A. E. Cullum, student. Dinner preceded the meeting. February 19. Attendance 50.

Inspection trips to the General Electric Company in East Boston and West Lynn. March 4. Attendance 32.

Michigan College of Mining and Technology

Discussion of plans and appointments of committees for electrical show. February 17. Attendance 74.

Michigan State College

Film—"The Single Ridge." February 24. Attendance 25.

School of Engineering of Milwaukee

The Radio Control of Garage Doors, by Mr. Nethercut, Barber-Colman Co. Demonstrated.

The Theory of the Photoelectric Cell, by Mr. Greisel, student. Karl Werwath, student, reviewed some of the latest developments in the electrical field. February 11. Attendance 75.

Missouri School of Mines and Metallurgy

Two films entitled "The Benefactor," and "Thomas A. Edison." December 18. Attendance 23.

Life of Faraday, by G. L. Leisher, student;

Description of the Life of Steinmetz, by Prof. I. H. Lovett, Counselor. M. R. James, student, gave a talk on his experiences while employed by the Union Electric Co. January 28. Attendance 16.

Business Meeting. February 11. Attendance 13.

Films—"Atomic-Hydrogen Welding" and "Aircraft Accessories." February 25. Attendance 167.

The Desire to Do a Thing, by Branch Rickey, vice-president of the St. Louis Cardinals. February 27. Attendance 423.

University of Missouri

Annual Dinner. Short talk by J. S. Palmer, Kansas City Power & Light Co. February 24. Attendance 43.

Marine Propulsion, by F. V. Smith, General Electric Co. Joint meeting with the A. S. C. E., and A. S. M. E. Branches. March 9. Attendance 50.

Montana State College

Film—"From Mine to Consumer." February 12. Attendance 152.

Why An Engineer Should Take Public Speaking, by Walter J. Williams, student;

White Lights North of Arctic Circle, taken from *Power Plant Engineering*, presented by Herbert Archibald, student;

Some Aspects of Federal Regulation of Water-Power Development, taken from Electrical Engineering, presented by James Pepper, student;

Detecting Hidden Fissures in Rails, taken from Electrical Engineering, presented by Ward Rightmire, student. February 19. Attendance 143.

Artificial Sunlighting Now Challenges the Sun, taken from *Electrical World*, presented by E. N. Blannin, student;

The Development of Lighting During the Year 1930, taken from *General Electric Review*, presented by Edward Fisher, student;

Gasoline Pump Motors, taken from *Electric Journal*, presented by Leonard Estey, student. February 26. Attendance 129.

Electricity and Light During 1930, taken from *Electrical World*, presented by Armin J. Hill, student;

Floating Electric Power Plant, by Homer T. Lambdin, student;

Constant-Voltage Regulators, by Paul McAdam, student. March 5. Attendance 134.

University of Nebraska

Oil Circuit Breaker Phenomena, by G. W. Swallow, American Brown Boveri Co. Inc. Film—"Electric Locomotives and Trains in Switzerland." February 3. Attendance 55.

Inspection trip through the U. S. Government Radio Monitor Station, conducted by Benjamin Wolf, manager of the Station; also through the Grand Island Sugar Beet Factory, conducted by U. Anderson, chemist. February 8. Attendance 28.

Picture Transmission by Wire, by Cecil Donley, Lincoln Telephone & Telegraph Co. February 18. Attendance 40.

Opportunity for Engineers Today, by Roy V. Wright, president, A. S. M. E. March 3. Attendance 120.

University of Nevada

Electricity and Its Application to the Mining Industry, by J. A. Fulton, director, Mackay School of Mines. February 4. Attendance 16.

Electric Water Purifiers, by Chester Elliott, student;

New Developments in Vacuum Tubes, by Jack Hough, student. February 11. Attendance 15.

Electron Tubes, by H. C. Stanley, General Electric Co. Illustrated with motion pictures. February 18. Attendance 68.

Newark College of Engineering

Direct-Coupled Amplifiers, by W. B. Wible, student;

Mercury Vapor Turbines, by S. F. Spence, student;

Generator-Voltage Regulation, by G. McSweeney, student. February 24. Attendance 32.

University of New Hampshire

Films—"The Potter's Wheel," "Revelations by the X-Ray," and "The Cat and the Kit." January 10. Attendance 36.

The Photoelectric Cell and Some of Its Applications, by J. J. Carlen, student. January 17. Attendance 36.

Electrification of Railways, by F. M. Jones, student. January 24. Attendance 33.

Harnessing Ocean Temperatures, by K. S. Savage, student;

A New Radio Battery that Breathes Air, by O. K. Reid, student;

Explanation and Demonstration of Magnetic Arc Blow-Out, by G. R. Walden, student;

Why Fraternities Should not Exist on a College Campus, by C. A. Dolloff, student;

Why Fraternities Should Exist on a College Campus, by H. R. Wood, student. January 31. Attendance 30.

Aluminum Electrolytic Condenser and Lightning Arrester, by P. J. Stafford, student;

Radio Programs by Electrical Transcription, by R. M. Sawyer, student;

Flood Control in the Mississippi Valley, by J. J. Cunningham, student. February 7. Attendance 34.

Films—"Turbines," and "Dynamic America." February 21. Attendance 35.

Induction Generators, by R. Osgood, student;

Aurora, The Elusive Mystery of Science, by F. Dickey, student;

The Polarized Bell, by C. Matoian, student;

Operation of D-C. Generators in Parallel, by L. Barker, student;

Why A-C. Current Leads the Voltage 90 Degrees with a Condenser in the Circuit, by F. Perkins, student. February 28. Attendance 34.

University of New Mexico

The Life and Work of Oliver Heaviside, by S. Fish, student;

Control by Radio, by H. Mendenhall and E. Huffman, students. February 26. Attendance 11.

College of the City of New York

Discussion of Branch activities. February 19. Attendance 15.

Business meeting. March 5. Attendance 18.

University of North Carolina

Block Signals, by A. C. Robertson, student;

Electrical Experiences, by O. J. McCall, student. February 12. Attendance 30.

Union Management Cooperation Through Research, by Morris L. Cooke, consulting engineer. Joint meeting with the Taylor Society. February 25. Attendance 90.

North Dakota State College

Annual Engineers' Banquet. My 30 Years' Experience Since Graduating from College, by M. S. Hyland, consulting engineer, Fargo, N. D. Film—"The Age of Riveted Steel." February 19. Attendance 108.

Preservation of Wood, by Wayne Curtis, student;

Film—"Blasting the Water Highways of America." February 25. Attendance 54.

University of North Dakota

General Electric Motors and Motor Application, by C. W. Randall, General Electric Co. February 11. Attendance 21.

Transportation Electrification, by Eugene Becker, student. March 4. Attendance 16.

University of Notre Dame

Thunderstorms and Lightning Discharge, by Prof. Daniel Hull, Dept. of Physics;

Resonance, by Edward Coomes, student;

Cross-Talk Elimination, by D. D. Mohler, student;

Life of Faraday, by A. V. Alvino, student. Patrick Murray presented the usual news digest. February 16. Attendance 68.

Turning the Light of Everyday Experience on the Economics of Today's Business and Related Activities, by L. B. Andrus, Central Indiana Power Co.;

Practical Telephony, by Henry Culver, student;

The Mercury Arc Rectifier, by Hugh Ball, student. Patrick Murray presented the usual news digest. March 2. Attendance 80.

Ohio Northern University

Film—"Government Aviation Developments." February 19. Attendance 38.

Discussion of future meetings and nomination of new officers. February 26. Attendance 24.

Looking Ahead in Aviation, by D. Cottrell, student. Election of officers as follows: O. R. Jacobs, president; B. Wyant, vice-president; W. Gideon, secretary; O. Hawes, treasurer. March 5. Attendance 18.

Ohio State University

Vacuum Tubes in Industry, by S. D. Fendley, General Electric Co. February 26. Attendance 22.

Ohio University

Film—"Induction Voltage Regulator." February 16. Attendance 8.

Oklahoma A. & M. College

Discussion of plans for the electrical show. February 5. Attendance 19.

Dry Cells—Their Manufacture and Use, by Paul Ratliff, student. Illustrated. February 12. Attendance 30.

Oregon State College

Safety in the Industries, by A. E. Eicken, National Safety Council. Illustrated with slides. February 16. Attendance 13.

Joint meeting with the Portland Section at which three papers were presented by students. (See report under "Past Section Meetings").

Discussion of Branch activities. March 2. Attendance 21.

University of Pennsylvania

The Thyratron Multi-Bopper Circuit, by Newbern Smith, student. February 19. Attendance 22.

Pratt Institute

Electric Railways, by J. L. Thomson, student;

Production of Aluminum, by N. J. Cherry, student. February 19. Attendance 15.

Purdue University

The Deion Circuit Breaker, by B. P. Baker, Westinghouse Electric & Mfg. Co. Illustrated with slides. February 10. Attendance 90.

Rensselaer Polytechnic Institute

Artificial Transients of Transmission Lines with Particular Reference to Performance of Lightning Arresters, by K. B. McEachron, General Electric Co. Illustrated with slides. February 10. Attendance 70.

Rose Polytechnic Institute

Illumination of Aviation Fields, by Bruce Wells, student. Film—"Aviation Lighting." March 4. Attendance 29.

University of Santa Clara

The Historical Development of the Allis-Chalmers Mfg. Co. and Their Motor and Dynamo Products, by William F. Snyder, Allis-Chalmers Mfg. Co. January 29. Attendance 105.

University of South Carolina

The Kaplan Automatic Adjustable Blade Turbine, by R. Brooks, student;

A Laboratory Method of Measuring the Capacity of Small Condensers, by C. L. Fishburne, student. February 16. Attendance 26.

The Vacuum-Tube Voltmeter, by J. W. Palmer, student;

Will You Lose Your Job Because of a New Machine, by J. B. Dent, student;

Electronic Tubes—Their Present and Future, by J. Oberschain, student. February 23. Attendance 30.

Business meeting. March 2. Attendance 9.

The Development of Motion Pictures, by R. Phillips, student;

Baron Munchausen Out-Lied with Truth, by David Peele, student. March 9. Attendance 29.

University of Southern California

Business meeting. February 4. Attendance 30.

L. A. Buese, Los Angeles Gas & Elec. Corp., discussed the remote control of substations by means of a step-by-step relay system. February 11. Attendance 32.

Aircraft Communication, by Del Mar Wright, Western Air Express and Transcontinental Air Transport, Inc. February 18. Attendance 32.

The Electrical Measurement of Acoustical Properties, by D. P. Loye, Electrical Research Products, Inc. February 25. Attendance 27.

Street Lighting, by O. W. Holden, Los Angeles Bureau of Power & Light. March 4. Attendance 30.

Stanford University

Transformer Construction, by W. C. Smith, General Electric Co. February 4. Attendance 21.

Stevens Institute of Technology

Life of Joseph Henry, by Donald Naughton, student. February 24. Attendance 21.

Syracuse University

Some Early A. I. E. E. Meetings, by Prof. C. W. Henderson, counselor. February 13. Attendance 23.

Measurement of Lightning Disturbances on Transmission Lines, by John Henderson, student;

The Bridge Transformer, by Richard Stone, student. February 20. Attendance 25.

Hydrogen-Cooled Generators, by Donald Brown and Ernest Wood, students;

Cooling Fins, by Edward Schweitzer and Stanley Scerbinski, students. February 27. Attendance 25.

Distribution System of Syracuse Lighting Co., by L. L. Cross, Syracuse Lighting Co. March 6. Attendance 24.

University of Tennessee

Debate—Copper Versus Aluminum Cables for Transmission Lines, by J. M. Brooks and J. Barnwell, students. February 19. Attendance 21.

University of Texas

Steam Generating Equipment, by O. K. Irvine, student;

Electrical Generating Equipment, by D. Sussin, Branch secretary;

Switchboard Equipment, by E. W. Toepperwein, student. February 12. Attendance 18.

University of Utah

Television, by Seth Pixton, illustrated. February 24. Attendance 25.

University of Vermont

Theory of the Stenode Radiostat, by A. L. Howard, student. February 24. Attendance 21.

Virginia Military Institute

Film—"Conowingo." February 18. Attendance 50.

500 M. P. H.—Can't Be Done, by F. A. Tyler, student;

What the Electrical Industries Themselves Expect of the Electrical Student, by R. E. Fort, student;

The Super-Magnetic Field, by E. R. Trapnell, Student. February 19. Attendance 46.

Virginia Polytechnic Institute

Discussion of Branch activities and of the recent lecture given by S. P. Grace, assistant vice-president, Bell Telephone Laboratories, Inc., entitled Marvels of Sound Transmission. February 12. Attendance 15.

Testing of Dry-Cell Batteries as Done at the Bureau of Standards, by M. H. Mills, student. February 26. Attendance 18.

Washington State College

Election of officers as follows: L. N. Hatfield, president; A. Keto, vice-president, G. C. O'Brien, secretary; H. Stingle, treasurer. January 21. Attendance 29.

Washington University

Discussion of Branch activities. February 26. Attendance 15.

West Virginia University

The following talks were given by students;

Electricity in the Cement Industry, by C. J. DeLavey;

Industry versus Technical Education, by R. W. Blair;

The Growth of 1930, by R. N. Kennedy;

Aeronautical Radio Communication, by C. J. McCormack;

Improvements to Make Elevators Faster and Safer, by J. N. Simpson;

Air-Cell Batteries, by K. De Moss;

Electrification of B. & O. Railroad, by R. C. Warder;

90 Miles per Hour in a Trolley Car, by J. M. Morgan. February 10. Attendance 25.

The following talks were given by students:

Flops by Famous Inventors, by H. V. Locker;

Electrical Industries, by M. L. Sprigg;

General Principles of Sound Recording, by V. S. Monteith;

Locating Hidden Fissures in Rails, by S. I. Boone;

Induction Type of Relay, by A. H. Goddins;

Removing Sleet and Ice from Transmission Lines, by L. P. Kerwin;

Varied Uses of the Photoelectric Cell, by W. C. McMillion. February 17. Attendance 27.

The following talks were given by students;

Induction of Electric Current by Michael Faraday, by P. N. Vannoy;

Early Life and Training of Faraday, by H. O. Webb;

Faraday's Experiments, by J. E. Newcomer;

Views of Faraday, by P. Shaff;

Life of Henry, by S. B. Wolfe;

Summary of Henry's Contributions, by T. E. Palmer. February 24. Attendance 33.

University of Wisconsin

Automatic Oscillographs, by J. D. Cobin, student;

Trends in Electrical Construction, by R. J. Nickles, Jr., student;

Copper Oxide Rectifiers, by J. L. Jones, student. Joint meeting with the Madison Section, sponsored by the Branch. February 18. Attendance 55.

Organization and Functions of the Construction Department of Commonwealth Edison Co. of Chicago, by Theodore Racheff, Branch secretary. Short talk on the life of Faraday given by Professor C. M. Jansky, counselor. November 26. Attendance 11.

University of Wyoming

Life of Faraday, by T. Hance, student;

Life of Joseph Henry, by A. Bucholz, student. Election of officers as follows: N. Sanders, Chairman; T. Hance, vice-chairman; Roy Perkins, secretary-treasurer. February 10. Attendance 13.

Yale University

Films—"Blasting the Waterways of America," and "The Single Ridge." Joint meeting with the A. S. M. E. Branch. February 10. Attendance 46.

The Simpler Types of Lightning Arresters, by L. A. Autuori, Branch secretary;

The Auto-Valve and Thyrite Arresters, by R. A. Hackley, student;

The Use of the Klydonograph on Power and Telephone Lines, by E. R. Eberle, student. February 19. Attendance 13.

Engineering exhibition held jointly with the A. S. M. E. Branch. February 23. Attendance 540.

Public Utilities Accounting System, by O. C. Rutledge, student;

Rate Structures and Schedules, by A. A. Watson, student;

Economic Factors of Electric Power Interconnections, by H. Geers, student. February 26. Attendance 13.

Biography of Michael Faraday, by F. W. Wolff, student;

Technical Aspects of Faraday's Experiments, by P. Thomson, student;

Biography of Joseph Henry, by J. D. Upton, student;

The Technical Ability of Joseph Henry, by L. Clare, student. R. M. Gerris, student, gave a history of the Sheffield Scientific School of Yale University. March 7. Attendance 28.

Employment Notes

Of the Engineering Societies Employment Service

Position Available

ASSISTANT to research engineer in automotive division of large manufacturing concern. College graduate in electrical engineering with GE or Westinghouse experience on electric automotive accessories, preferred. Apply by letter. Location, New England. W-2498.

Men Available

JUNIOR ENGINEER, 1930 graduate, B. S. and E. E. degrees. Practical experience in general electrical measurements and knowledge of radio receiver construction. Desires position in electrical or mechanical engineering where technical knowledge is principal requirement, as research, design, or testing. Location preferred, in or near New York City. C-8813.

ELECTRICAL ENGINEER, graduate of European technical college, with eight years' of varied and successful research experience in the United States. At present employed. Desires responsible position in the development or consulting department of a concern located in or near New York. B-6782.

GRADUATE ELECTRICAL ENGINEER, 31, married, with seven and one-half years' experience including: two and one-half years as engineer with manufacturer's service shop, two years university instructor, two years responsible position in manufacturer's engineering department and one year as electrician on station construction. Desires position with manufacturer, industrial concern or public utility. Available on short notice. C-1073.

GRADUATE ELECTRICAL ENGINEER, 25, single. Reared in the Orient, traveled widely, one year test course with motor manufacturer, one year sales experience on Pacific Coast. Desires permanent location with a company looking forward to an expansion in its foreign business. Available at once. Location, anywhere in United States. B-6945.

CONSULTING ENGINEER with long and successful experience in development and improvement of electrical devices including specialities in signaling, lighting, regulating, and railway fields. Desires additional connections. Especially interested in manufacturers' problems regarding new products and improvement of old products. C-8843.

ELECTRICAL ENGINEER, graduate Georgia Technology, 1930. Cooperative plan, worked alternate months, five years substation maintenance and office engineering. Rebuilding transformers, switches, lightning arresters, work with electric furnaces, rectifiers, motors, etc. Checking and mapping distribution systems, work orders, drafting. Single, excellent physical condition. Desires position, preferably with utilities. Location, immaterial. C-7847.

ELECTRICAL ENGINEER, B. S. degree from recognized Southern University, 24, single. Eighteen months on power transformer test, part of which was high-voltage and other experimental test. Desires position with future. Location and salary secondary to opportunity. C-8881.

PROFESSOR OF ELECTRICAL ENGINEERING, 49, 18 years' of successful teaching experience in both d-c. and a-c. circuits and machines, and theory of transmission. Denominational college. B. E. in E. E. and M. S. degrees. Location preferred, South. B-2675.

GRADUATE ELECTRICAL ENGINEER, 1930, 22, single, seven months on Westinghouse engineering course. Desires position with company in field of electrical or physical measurements and testing. Available at once. Location, immaterial. C-8875.

ELECTRICAL ENGINEER, graduate Rensselaer Polytechnic Institute, age 33. Five years with engineering department of large manufacturer of electric control apparatus. Four years with leading engineering firm as electrical designer on central station and industrial work. Specialized on switchboard and wiring design. Some sales experience. Now employed. Desires more responsible position. B-6274.

ELECTRICAL ENGINEER, bachelor and master degrees; 14 years' peculiarly broad experience in test, research and development, standardization, consultation, university teaching, executive work, personnel; familiar with both power and radio equipment and practise. Stability and opportunity primary; initial salary and location secondary. Available at once. C-4591.

ELECTRICAL ENGINEER, 32, married. Seven years with manufacturer on design of electric traction equipment and control apparatus. General engineer. Experience writing specifications, reports, technical papers. Teacher of mathematics. C-8896.

GRADUATE ELECTRICAL ENGINEER, B. S. Degree. One and one-half years with large electrical manufacturing concern in test and research departments. Also familiar with repair work on distribution transformers and other apparatus. Available on short notice. Location preferred, New England or eastern part of country. C-8075.

PROFESSOR OF ELECTRICAL ENGINEERING, 34, eight years' experience in teaching most branches of electrical engineering, state school. Holds broadcast class, limited operator's license. Five years' experience operation and maintenance of college broadcast transmitter; B. S. in E. E. and E. E. degrees. Location preferred, East, Middle West. Available school year 1931-32. C-8916.

ELECTRICAL ENGINEER, technical graduate, G. E. test and over 18 years' varied experience, including electrical manufacture; railway construction, valuation and maintenance; power-line construction and steam railroad electrification. Desires position with company doing consultation and construction engineering or with operating company. B-7456.

PROFESSOR OF ELECTRICAL ENGINEERING, 32, married, B. S. (E. E.) and E. E. Three years with General Electric Company, five years with public utility, four years' teaching and administrative experience in state university. Excellent references. Available for next academic year. Correspondence invited. C-7152.

ELECTRICAL AND ILLUMINATING ENGINEER, 41, married, 23 years' experience, wireman to superintendent, estimator and engineer, instructor in applied electrical engineering. Experienced in power station, commercial and industrial building wiring. Six years' engineering for architects, writing specifications, designing electrical installations, office buildings, theatres, hotels, schools, hospitals, industrial buildings. C-8460.

DRAFTSMAN-DESIGNER, electrical engineer, German Technical Institute, 32, married. Eight years' foreign, three and one-half years' American experience in design of electrical apparatus and radio receivers. Desires permanent, related position. Location preferred, Newark or New York. C-8787.

ASSISTANT PROFESSOR OR INSTRUCTOR IN ELECTRICAL ENGINEERING, eight years' teaching experience in d-c. and a-c. theory, electrical machinery, radio, dynamo laboratory, and electrical measurements; four years' commercial experience in power, lighting, radio and general electrical equipment design. Available for fall term. C-6302.

GRADUATE MAINTENANCE ENGINEER, 26, married; eight years' varied experience, operating steam turbines, high-voltage a-c. remote control board, hand switching, and power-house apparatus of all kinds. Also construction and electrical maintenance work of all kinds in chemical and cement plants. Now unemployed. Will accept first reasonable offer. C-8522.

PROFESSOR OF ELECTRICAL ENGINEERING, 40, six years' successful experience teaching practically all branches electrical engineering, state school. Considerable experience power, telephone work. One year switchboard engineering department of Westinghouse; B. S. in E. E. and E. E. degrees. Prefer location, Rocky Mountain, Pacific Coast States. Available school year 1931-1932. C-5021.

1929 GRADUATE heading university, B. S. E. E., desires position giving experience cable installation. One year's experience large power company laying out underground network distribution system. One year's experience rubber-insulated cables, electrical testing laboratory large cable manufacturer. Can handle men. Working knowledge French, Spanish; elementary knowledge German. Location, immaterial. C-6408.

ELECTRICAL DESIGNER, age 36, married. Ten years' public utility experience in steam and hydroelectric plants, substations and industrial plants. Also served four years as fire insurance inspector. Graduate of technical school on electrical and mechanical subjects. C-7979.

ELECTRICAL ENGINEER, 47, college graduate, married. Twenty-six years' experience as designing, report, power and executive engineer with three engineering firms. Experience includes cost estimating for plant and transmission facilities, design, construction supervision, operating economics with fuel and hydro plants, system planning for public utility and industrial properties. B-4553.

ELECTRICAL ENGINEER, 1930 graduate, desires position. Experience in drafting, radio service, electric-meter testing. Recently technical representative for large radio-phonograph concern. Excellent references. C-8578.

ELECTRICAL DESIGNER AND DRAFTSMAN, age 31, single. Eight years' public utility experience in steam and hydroelectric plants, substations and industrial plants. Graduate of technical school in mechanical and electrical engineering. Desires position with public utility or industrial company. C-4510.

DIRECTOR OF EDUCATION AND TRAINING with national technical corporation, formerly assistant professor of electrical engineering, 5 years at leading technological college. Experienced administration educational work. Desires position professor electrical engineering, head of department at medium sized or small college where development and expansion is possible, or associate professorship in large technical college. C-8967.

ELECTRICAL-MECHANICAL ENGINEER, graduate, age 34, married. Experienced, design, manufacture and application of motors and generators. Past five years in district sales office of large manufacturer, contacting central stations and large industrial concerns both in operating problems and sales promotion. Desires a job where initiative, energy, and results will count. B-9432.

ELECTRICAL FOREMAN, 38, married. Eighteen years' experience covering power plant, substation, industrial, construction and maintenance. Have headed these departments for years. Especially qualified to take charge of actual work under a busy executive. C-2028.

ELECTRICAL ENGINEER, 31, B. S. E. E. 1926. One year assistant electrical engineer making preliminary studies, investigations on hydroelectric projects; one year engineer electrical control of armament on aeroplanes; two years material inspection, street railway company; one year student engineer large public utility; two years' electric car shop experience. C-6077.

GENERAL ENGINEER, 27, married, A. B., and B. S. in E. E. degrees. Experienced in steam power plants, water-works, industrial electrical equipment maintenance, underground power system construction and maintenance, and oil refinery equipment standardization and maintenance. Desires engineering position along line of experience that has possibilities for advancement. Location, immaterial. C-8982.

PLANT ENGINEER, age 47, married, two children, two degrees in E. E. Over twenty years' experience in design, construction, maintenance and operation of all mechanical equipment for buildings, building construction; factory facilities, steam and hydraulic power plants. Understands efficient handling of large groups of men. Location, South, Central West or Northeast. C-8868.

ELECTRICAL ENGINEER, 36, married, university graduate. Eighteen years' experience in design, construction, maintenance and operation of hydroelectric stations, distribution and transmission systems, also design and construction of steam stations. Last five years with large consulting firm. Initiative and ability to produce. C-8980.

GRADUATE ELECTRICAL ENGINEER, 33, eight years' experience in high-voltage research. Wishes position with switch manufacturer in design work. Location, anywhere. C-8981.

ELECTRICAL ENGINEER, 25, single. Cornell University graduate in E. E. Two years' drafting experience with large engineering concern. One year in manufacturing plant as assistant to plant engineer. Desires permanent position with a future with a utility or engineering company. C-8949.

GRADUATE ELECTRICAL ENGINEER, age 23, single, 21 months of Westinghouse Test on rotating machinery and control, B. S. in E. E. 1929, at present pursuing graduate study. Desires position as engineering instructor or in any electrical line offering a future. Available immediately. Eastern Location preferred. C-8966.

SALES AND EXECUTIVE ENGINEER, trained at Worcester Polytechnic Institute. Seven years' sales experience: straight sales eneneering, jobbing sales, sales management, saels promotion. Has contacted with electrical and mechanical companies. Traveled East, Middle West, South. Well acquainted with New England. C-5431.

ASSISTANT PROFESSOR OR INSTRUCTOR in electrical engineering. Three years development and research engineer on communication apparatus. Five years head of electrical department in large industrial school. At present on E. E. staff of recognized university, teaching electrical design and other electrical engineering subjects. Available in September. C-2893.

GRADUATE ELECTRICAL ENGINEER, age 28, married, with 8 years' industrial control, power plant design and construction supervision experience with contractor. Desires position with public utility or manufacturing concern's engineering or construction departments. Location desired, Middle West. C-4428.

GRADUATE ELECTRICAL ENGINEER, age 26, single, 4½ years' experience with Westinghouse Electric and Mfg. Co. including graduate student course and two engineering departments. Has done experimental and application work on industrial devices using electronic tubes, particularly photo-tubes. This includes some design work, technical correspondence and diagram drafting. Available early summer. C-8888.

GRADUATE ELECTRICAL ENGINEER, 25, obtaining Master's Degree in June, 1931, desires position as assistant professor or instructor in electrical engineering, or as research engineer. Four summers' employment with large utility company. Two years' teaching experience. Has had experience with development of remote-control apparatus. Available July 1, 1931. Location, United States. C-8994.

EFFICIENCY ENGINEER, industrial electrical graduate with broad experience in application of electric drive and design of complete power layout in plants. Experience also includes considerable time with power companies and refrigeration companies. Available on short notice. Location, immaterial. A-4018.

1929 GRADUATE, E. E. degree. Fourteen months on General Electric Test. Assignments covered work on radio and vacuum development and testing all types of electrical equipment. Available immediately. C-1879.

GRADUATE ELECTRICAL ENGINEER of Purdue University with 18 years' experience in design, construction, estimating, costs, valuation and appraisal of power plants, substations, transmission lines and industrial plants including five years in heavy electric traction and rapid transit work. Open for opportunity with future. C-8256.

GRADUATE ELECTRICAL AND MECHANICAL ENGINEER, 36, desires connection with public utility or industrial firm on power-station operation as engineer, or as assistant to superintendent or engineer. Ten years' experience in power plant test, operation, design, construction, and maintenance. Three years electrical engineer for industrial firm. Two years assistant to power engineer. B-8379.

ELECTRICAL ENGINEER, 28, married, 4 years out, now employed. One year power utility course, three years telephone and talking pictures. Previous experience as commercial radio operator. Would be valuable to concern requiring services of capable engineer. Position must be permanent with future. Location secondary factor. Best of references available. Correspondence invited. C-7902.

ELECTRICAL ENGINEER, graduate 1931, 26 years, single. Desires position in Mexico or South America. Speaks and writes Spanish. An engineering work in radio or any electrical enterprise with opportunity for advancement is desirable. References. C-8662.

ELECTRICAL ENGINEER, B. E. E., class 1918. Two years teaching, two years sales promotion, five years design power houses, substations, transmission, equipment specification and purchases, switchboards, control, etc. Four years plant engineer. Available April 1st. C-8942.

ENGINEERING SOCIETIES EMPLOYMENT SERVICE

57 Post St.	205 West Wacker Drive	31 West 39th St.
San Francisco	Chicago	New York
N. D. Cook, Manager	A. K. Krauser, Manager	W. V. Brown, Manager

MAINTAINED by the national societies of civil, mining, mechanical, and electrical engineers, in cooperation with the Western Society of Engineers, Chicago, and the Engineers' Club of San Francisco. An inquiry addressed to any of the three offices will bring full information concerning the services of this bureau.

Men Available.—Brief announcements will be published without charge; repeated only upon specific request and after one month's interval. Names and records remain on file for three months; renewable upon request. Send announcements direct to Employment Service, 31 West 39th Street, New York, N. Y., to arrive not later than the fifteenth of the month.

Opportunities.—A weekly bulletin of engineering positions open is available to members of the cooperating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

Voluntary Contributions.—Members benefiting through this service are invited to assist in its furtherance by personal contributions made within 30 days after placement on the basis of 1.5 per cent of the first year's salary.

Answers to Announcements.—Address the key number indicated in each case and mail to the New York office, with an extra two-cent stamp enclosed for forwarding.

Membership

Applications for Election

Applications have been received by the Secretary from the following candidates for election to membership in the Institute. Unless otherwise indicated, the applicant has applied for admission as an Associate. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the Secretary before April 30, 1931.

Abara, L. L., Associated Gas & Electric System, Cambridge, Mass.

Arnold, J. S., Western Electric Co., Chicago, Ill.

Bailey, C. R., Wisconsin Telephone Co., Milwaukee, Wis.

Beaumont, F. E., Otis Elevator Co., New York, N. Y.

Brayman, C. E., J. J. Murphy & Son, Hartford, Conn.

Brooks, J. F., American Tel. & Tel. Co., New York, N. Y.

Caldwell, R., Idaho Power Co., Melba, Idaho

Campbell, A. T., Southwestern Bell Tel. Co., Kansas City, Mo.

Carroll, B. J., Western Electric Co., Kearny, N. J.

Carter, J., New York Edison Co., New York, N. Y.

Collins, F. H., (Member), Kansas Gas & Electric Co., Wichita, Kans.

Cory, H. M., Buffalo, Niagara & Eastern Power Corp., Buffalo, N. Y.

Crozier, C. J., New York Telephone Co., New York, N. Y.

Dare, T. J., Oklahoma Gas & Electric Co., Oklahoma City, Okla.

Deinert, C. R., Bell Telephone Co. of Pa., Pittsburgh, Pa.

Dellgren, H. F., Brooklyn Edison Co., Brooklyn, N. Y.

Downing, C. R., Public Service Co. of Okla., Tulsa, Okla.

Dunham, J. M., American Tel. & Tel. Co., New York, N. Y.

Eggertson, E. G., Safe Harbor Water Power Corp., Baltimore, Md.

Faile, E. H., (Member), E. H. Faile & Co., New York, N. Y.

Fox, E., Southern Public Utilities Co., Salisbury, N. C.

Freeland, E. L., Western Electric Co., Chicago, Ill.

Geiges, K. S., Underwriters' Laboratories, New York, N. Y.

Gonzalez, J., Power Plant, Rosita, Coah., Mexico

Harris, R. F., (Member) Heald's Engineering College, San Francisco, Calif.

Hoffman, R. E., Western Electric Co., Inc., Chicago, Ill.

Holsten, F. H., Bell Tel. Labs., New York, N. Y.

Huisking, J. C., The Philip Carey Co., New York, N. Y.

Jones, E. W., Cornell University, Ithaca, N. Y.

Jones, K. B., General Electric Supply Corp., Toledo, Ohio

Katz, H., 1339 Bristow St., New York, N. Y.

Kramer, R. S., (Member), N. J. Bell Tel. Co., Newark, N. J.

Kuehne, H. A., General Electric Co., Schenectady, N. Y.

Kuhlman, E. C., Southwestern Bell Tel. Co., Kansas City, Mo.

Laitinen, A., General Electric Co., New York, N. Y.

Loy, J. M., University of Oklahoma, Norman, Okla.

Major, F.H., Allied Engineers, Inc., Atlanta, Ga.

Mecum, E. J., Chicago District Elec. Gen. Corp., Chicago, Ill.

Melhorn, N. R., Jr., American-Brown Boveri Co., Inc., Camden, N. J.

Newton, J. C., Long Island Railroad, Woodhaven Junction, Woodhaven, N. Y.

Nippes, I. S., (Member), Elliott Co., Ridgway, Pa.

Oglebay, W. J., Buffalo, Niagara & Eastern Power Corp., Buffalo, N. Y.

Patterson, W. H., Edison Storage Battery Co., Orange, N. J.

Perkins, B. B., United Sugar Companies, S. A., Los Mochis, Sinaloa, Mexico

Petrasek, R. F., Carrier Construction Co., Newark, N. J.

Quintero, R., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Robinson, T. B., Allis-Chalmers Mfg. Co., Pittsburgh, Pa.

Rozelle, P. M., Western Electric Co., Inc., Chicago, Ill.

Sahagen, J., General Electric Co., Lynn, Mass.

Schirtzinger, H. A., Western Electric Co., Atlanta, Ga.

Stern, J., Western Electric Co., Kearny, N. J.

Stevens, L. J., Locke Insulator Corp., Baltimore, Md.

Stuntz, H., 366 N. 12th St., Newark, N. J.

Todd, H. F., Chicago Technical College, Chicago, Ill.

Underwood, C. M., Western Electric Co., Chicago, Ill.

Wall, H. F., (Member), City of Detroit, Detroit, Mich.

Waugh, W. R., 1113 Pleasant St., Indianapolis, Ind.

Wright, R. A., Pennsylvania Railroad Co., Pittsburgh, Pa.

Total 58

Foreign

Johannessen, B. L., A. S. National Industri, Drammen, Norway

Peacock, G. M. C., Metropolitan-Vickers Electrical Co., Manchester, Eng.

Pinkney, W. H., English Electric Co., Ltd., Stafford, Eng.

Total 3

Engineering Literature

New Books

In the Societies Library

Among the new books received at the Engineering Societies Library, New York, during January are the following which have been selected because of their possible interest to the electrical engineer. Unless otherwise specified, books listed have been presented gratis by the publishers. The Institute assumes no responsibility for statements made in the following outlines, information for which is taken from the preface or text of the book in question.

Applications of Interferometry. By W. Ewart Williams. N. Y., E. P. Dutton & Co., 1930. 104 pp., diagrs., 7 x 4 in., cloth. \$.85.——This little book provides a useful description of the various types of interferometers and explains the principles of each type. The scientific and technical applications of interference methods are pointed out, and useful lists of references are given. The work is a useful introduction to the subject for engineers and physicists.

Das Buch der Grossen Chemiker, Bd. 2; von Liebig bis Arrhenius. By Günther Bugge. Berlin, Verlag Chemie, 1930. 559 pp., illus., ports., 9 x 6 in., cloth. 32 r. m.——The development of chemistry during the last century is well covered by this collection of biographies of great chemists, from Liebig to Arrhenius. Each biography gives the salient facts about its subject and points out clearly his contributions and their effect upon the growth of the science. The reader not only learns to know the individuals, but also gets a good grasp on the history of chemistry.

Economic Control of Engineering and Manufacturing. By Frank L. Eidmann. N. Y., McGraw-Hill Book Co., 1931. 402 pp., illus., diagrs., tables, 9 x 6 in., cloth. \$4.00.——Points out problems of engineering and manufacturing which must be solved by economic analysis and presents methods of procedure for their solution. Among the matters discussed are the choice between different types of equipment, the determination of the economy of proposed changes in equipment, processes or methods, the proper amount of materials to keep in stock, the economic effects of artificial illumination, and similar problems.

L'Évolution et le Développement des Principales Industries depuis Cinquante Ans, 1880-1930. Issued by

Genie Civil as a special number. Paris, Jules-Lefebvre, 1930. 236 pp., illus., 14 x 11 in., paper. 25 fr.——In commemoration of its fiftieth anniversary, the "Génie Civil" has issued a special number devoted to a review of the progress of engineering during the half century. Forty-two articles by eminent specialists describe developments in public works, mining, agriculture, roadbuilding, railroads, etc. The publication is a valuable historical summary.

Lehrbuch der Bergwerksmaschinen (Kraft- und Arbeitsmaschinen). By H. Hoffmann and C. Hoffmann. 2d edition. Berlin, Julius Springer, 1931. 402 pp., illus., tables, 11 x 8 in., cloth. 24 r. m.——A comprehensive treatise upon mining machinery, which not only describes the different machines used but also discusses the mine power plant and the distribution of power. Starting with a chapter on thermodynamics, the author discusses fuels, boilers and boiler plants, piping, steam engines and turbines, and internal-combustion engines. Hoisting machinery, pumps, compressors, compressed-air machinery, refrigerating and ventilating equipment, and electrical machinery are then described.

Machines Électriques. By A. Mauduit. 4th edition. (Électrotechnique Appliquée). Paris, Dunod, 1931. 2 v., 1738 pp., diagrs., 10 x 7 in., bound, 306,50 fr.; paper, 284,50 fr.——These two large volumes by Professor Mauduit, of the University of Nancy, treat of the theory, testing and construction of electrical machines. Both a-c. and d-c. machines are included. The subject is treated both theoretically and practically, from the plant engineer's point of view rather than for the designer.

Physics. By Oscar M. Stewart. Revised edition. Boston, Ginn & Company, 1931. 770 pp., illus., diagrs., 9 x 6 in., cloth. $4.00.——A thoroughly revised edition of a popular elementary college textbook. The book is intended especially for those who are studying physics as part of a general course in the arts and sciences and have no special training in mathematics. The book aims to give a good grasp of the fundamental principles of physics, to illustrate them by everyday examples, and incidentally to train the student in the scientific method of reasoning.

Radiations from Radioactive Substances. By Sir Ernest Rutherford, James Chadwick and C. D. Ellis. N. Y., Macmillan Company, 1930. 588 pp., illus., diagrs., tables, 9 x 6 in., cloth. $6.50.——This new work by the famous investigator of radioactive phenomena will be welcomed by all students of the subject. It is concerned not with the transformations of radioactive substances but with the rays that accompany the transformations and the effects that these radiations produce while passing through matter. A concise, connected account of our knowledge of the radiations is given, and the bearing of the results on the problem of the structure of the nucleus of the atom is discussed.

Reports and Papers, 1930. American Society of Mechanical Engineers Research Committees. N. Y., A. S. M. E., 1931. Various pagings, illus., diagrs., tables, 11 x 8 in., bound. $4.00.——A record of the latest achievements of the various research committees of the Society. The topics discussed include antifriction bearings, boiler metal failures, Diesel fuel oil, lubrication, management, mechanical springs, metal cutting, metal at high temperatures, thermal properties of steam and wire rope.

These papers have appeared in the *Transactions* of the A. S. M. E. and in *Mechanical Engineering*. They reappear in this volume in convenient form for preservation.

Sur l'Utilisation de la Chaleur dans les Machines a Feu. By Henri B. Reitlinger. Paris & Liége, Ch. Béranger, 1930. 254 pp., 10 x 7 in., paper. 60 fr.——An investigation of the complex phenomena involved in the operation of a thermal power plant, undertaken to develop a method by which the conditions for securing maximum efficiency of the plant, as a whole, may be determined. The author first presents the laws governing the thermostatic and thermodynamic transformations in a new form which enables him to obtain a more complete view of the utilization of the heat than can be obtained by the usual methods. He then applies the results of the method to the solution of practical problems and shows how they may be used in the design of power plants of various kinds.

ORDER FORM FOR REPRINTS OF FULL PAPERS ABRIDGED IN THIS ISSUE OF *ELECTRICAL ENGINEERING**

(April 1931) Number	Author	Title
☐ **30-191**	E. R. Stauffacher	Development of a Relay Protective System
☐ **31-3**	J. B. MacNeill	The Trend in Development of Modern Circuit Interrupters
☐ **31-6**	Malcolm Thomson	Resistance Welding of Motor Frames
☐ **31-8**	J. W. Milnor	Submarine Cable Telegraphy; Influence of Interference
☐ **31-11**	K. B. McEachron and E. J. Wade	Field Tests on Thyrite Lightning Arresters
☐ **31-19**	S. R. Bergman	A New System for D-C. Arc Welding
☐ **31-22**	H. L. Wills and O. B. Blackwell	Noise-Frequency Induction
☐ **31-23**	R. N. Conwell and H. S. Warren	Low-Frequency Induction
☐ **31-35**	R. M. Baker	Commutation and Current Collection in Hydrogen
☐ **31-58**	A. J. Dreux and H. C. Brunner	A Modern Electrified Dairy Plant

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Ammeters

HIGH FREQUENCY. Un Ampèremetre pour très hautes fréquences (Ammeter for Very High Frequencies). *Industrie Electrique*, vol. 39, no. 924, Dec. 25, 1930, pp. 558-561, 3 figs. Theory and construction details of hot-wire instrument measuring up to 100 million cycles; performance and correcting calculations are given.

Cables

MANUFACTURE. Aids to Better Cable Production. *Elec. World*, vol. 97, no. 4, Jan. 24, 1931, p. 197, 3 figs. Anaconda Wire & Cable Co. in production of its high-voltage cable is employing lead press specially equipped to maintain uniform thickness of lead sheath, and special facilities for determining power factor, capacity, dielectric loss, breakdown, ionization, and life of cable under cyclic loading; transformers up to 750,000 volts are used for testing.

TESTING. Cable Testing in the Detroit Edison Company, E. J. Manuel. *Elec. Light and Power*, vol. 9, no. 2, Feb. 1931, pp. 30-32, and 34, 5 figs. Cable testing in Detroit Edison Company is done with kenotron which has advantages of light weight and compactness, making it possible to mount testing equipment in truck or trailer and move hurridly to any desired location; set may be operated from either 110- or 220-volt supply; disadvantages to use of high voltage a-c. for testing purposes, are enumerated.

RADIO. Underground Circuits for the Transmission of Broadcast Programmes, A. C. Timmis and C. A. Beer. *Post Office Elec. Engrs., Jl.*, vol. 23, pt. 4, Jan. 1931, pp. 315-321, 4 figs. Essential part of Regional Broadcasting System in England now being constructed is network of land lines or repeater circuits which link up studios in London and elsewhere with radio transmitters, so that program from any studio may be radiated from all or any of transmitters; analysis of main considerations involved in faithful transmission of music under commercial conditions.

TELEGRAPH — FAULT LOCATION. Stoerungsdienst zur Beseitigung von Kabelfehlern unter besonderer Beruecksichtigung der Stoermungsbeseitigung in Verteilungskabeln beim Telegraphenbauamt Berlin, F. Glass. *Telegraphen und Fernsprechtechnik*, vol. 19, no. 12, Dec. 1930, pp. 382-387, 10 figs. System and methods are described.

TELEPHONE. Notable Telephone Developments in 1930. *Telephone Engr.*, vol. 35, no. 1, Jan. 1931, pp. 17-18, 1 fig. World communication during past year has made great strides toward giving all countries daily telephone service with each other, either by direct radio circuits or through land lines from radio terminals.

UNDERGROUND. Some Notes on Underground Cables, E. S. Simkins. *Iron and Steel Engr.*, vol. 8, no. 1, Jan. 1931, pp. 32-34. Factors controlling current carrying capacities with particular regard to properties of various insulating materials; operating temperatures of rubber, varnished cambric and paper insulation; thermal characteristics of duct structure and protection of cables after installation.

Circuit Breakers

Modern Switchgear Developments, F. G. Sublet. *Elec. Times*, vol. 9, nos. 10, 11 and 12, Oct. 27, 1930, pp. 633-636, Nov. 27, pp. 676-678, and Dec. 27, pp. 751-756, 9 figs. Functions of circuit breaker; rupturing capacity tests; oil piston theory for oil circuit breaker; recent experimental developments; electric air; air blast circuit breaker.

OIL. The Distribution of Energy Liberated in an Oil Circuit Breaker; with a Contribution to the Study of the Arc Temperature, C. E. R. Bruce. *Instn. Elec. Engrs.—Advance Paper*, received Dec. 1, 1930, 25 pp., 7 figs. Manner of dissipation of this energy is dealt with in considerable detail for various currents and for 5,500 volts (r. m. s.); energy dissipated at contact surfaces; energy radiated from arc; energy required to heat, vaporize and break up oil; energy used in raising gas to arc temperature and energy used in dissociating hydrogen present.

Condensers

MEASUREMENT. A New Method of Measuring the Capacity of Small Condensers, H. M. Barlow. *Lond., Edinburgh and Dublin Philosophical Mag. and Jl. of Science*, vol. 11, no. 68, Jan. 1931, pp. 184-193, 4 figs. One of best methods is to employ commutator to charge and discharge it with periodicity that can be accurately determined; when dealing with condensers under about 100 micro-microfarads really accurate observations are not then possible; with object of overcoming this difficulty attempt was made to employ two thermionic tubes in place of commutator, charging and discharging of condenser being controlled by alternate positive and negative potentials applied to grids.

Conductors

Temperature Rise of a Conductor due to the Electric Current, Y. Ikeda and K. Yoneta. *Hokkaido Imperial University—Faculty of Eng.—Memoirs*. vol. 2, no. 5, Dec. 1930, pp. 107-145. Mathematical analysis of temperature rise of thin wire and strip with rectangular cross section; results can be applied exactly to problem of fusion of fuse as shown in later paper in same issue; application to design of dimension of galvanometr-string and that of electric heater. (In English).

Control

MACHINE TOOLS. Control of Individually Driven Machine Tools, C. H. S. Tupholme. *Mech. World*, vol. 89, no. 2296, Jan. 2, 1931, pp. 9-10. Maximum output and greatest flexibility of operation are obtained only when motor-driven machine tools are equipped with some form of automatic control; all automatic controlling devices divided into two classes: one known as time acceleration starters, and other as current-limit starters or series relays; complete control from one point is of greatest value for many classes of work, as workman can change speed at will as best suits work as it progresses.

Culture

ENGINEERING. Engineering Culture, H. F. Moore. *Science*, vol. 73, no. 1881, Jan. 16, 1931, pp. 51-54. It is not justifiable in author's opinion to exclude from any system of general culture consideration of viewpoint, either of scientific method, or of viewpoint of applied science; is it not just to call a man uncultured who knows history and philosophy of heat engine, but is ignorant of music, while musician is hailed as cultured, who is master of his technique but contemptuous of science which has made possible modern pipe organ; some positive contributions of engineering to culture are cited. Address before Am. Assn. Advancement Science, Dec. 30, 1930.

Dielectrics

Dielectric Phenomena at High Voltages, B. L. Goodlet, F. S. Edwards and F. R. Perry. *Instn. Elec. Engrs.—Advance Paper*, received Dec. 16, 1930, 33 pp., 32 figs. Breakdown of air, oil and solid dielectrics by normal frequency, impulsive and high frequency voltage; large amount of original numerical data is given, covering entire range of voltage up to one million volts.

Economics

ENGINEERING. Engineering, Economics, and the Problem of Social Well-Being—The Engineer's View, R. E. Flanders. *Mech. Eng.*, vol. 53, no. 2, Feb. 1931, p. 99-104. Social problems presented by business cycle for solution by engineers; more complete science of economics needed; inter-relations of engineering, science and invention; work for coal engineer.

Electric Discharge

The Potential of the Walls in the Cathode Dark Space, J. W. Beck and K. G. Emeleus. *Lond., Edinburgh and Dublin Philosophical Mag. and Jl. of Science*, vol. 11, no. 68, Jan. 1931, pp. 54-64, 8 figs. Method for finding potentials in cathode dark space has recently been developed; which affords test of Morse's theory of dark space and leads to determination of Townsend's ionization for electrons; Brown and Thomson's values for these differ somewhat from Townsend's and it was thought that this might be due in part to effect of wall charges in discharge-tubes used by them; for this and other reasons it seemed of interest to undertake investigation of wall potential described.

Electric Drive

CENTRIFUGES. The Application of Electric Motors to the Driving of Centrifugal Machines. *Engineer*, vol. 151, no. 3915, Jan. 23, 1931, p. 112, 1 fig. Notes based on information supplied by Pott, Cassels and Williamson, of Motherwell, have been confined principally to induction motors which are mainly used in sugar factories and refineries, owing to provision of three-phase supply; when d-c. is used friction clutches are usually interposed between centrifugal and motor.

COMPRESSORS. Two-Speed Synchronous Motors Drive Compressors, H. E. Larson. *Power*, vol. 73, no. 4, Jan. 27, 1931, p. 138-141, 8 figs. Five synchronous-motor torques are considered in application of equipment to reciprocating compressor drives; to allow operating compressors are reduced output two-speed synchronous motor has been developed and machines of that type are now in service.

ROLLING MILLS. Main Roll Drive Statistics.—1930. *Iron and Steel Engr.*, vol. 8, no. 1, Jan. 1931, pp. 34-38. Tabulated lists of main roll drives installed in 1930 in United States and Canada; showing hp., r.p.m., voltage, cycles, type and size of mill, method of drive, date of purchase, name of plant and location.

STEEL PLANTS. Electrical Equipment for Steel Mills, H. A. Winne. *Blast Furnace and Steel Plant*, vol. 19, no. 1, Jan. 1931, p. 109-110. Data on outstanding features of mill drives installed during 1930; reversing mill drive; d-c. main drives; motor driven heavy shears.

Electric Furnace

Recent Trends in Electric Heating, G. M. Bayne. *Elec. News*, vol. 40, no. 3, Feb. 1, 1931, pp. 79-80, 1 fig. New types of highly efficient electric furnaces available for specific requirements indicate that application of electric heat-treating is only on its infancy.

Electric Furnaces: Their Development and Application, V. O. Cutts. *Metal Industry (Lond.)*, vol. 38, no. 3, Jan. 16, 1931, pp. 78-80 and 99-100, 6 figs. Economic considerations; non-ferrous metal and melting furnaces; induction furnaces for melting; adoption of electric heating never results in inferior product; it often renders possible improved product.

ALUMINUM ALLOYS. The Heat Treatment of Aluminum Alloys in the Electric Furnace. *Metal Industry (Lond.)*, vol. 38, no. 3, Jan. 16, 1931, pp. 81-82, 6 figs. Two typical alloys, 17S and 51S, are considered with view to illustrating function of heat treatment; artificial aging.

ANNEALING. Varies Annealing Temperature by Induction Regulator, R. W. Miller. *Steel*, vol. 88, no. 5, Jan. 29, 1931, pp. 38-40, 3 figs. Operation and design of electric annealing furnaces by Brown, Boveri & Co., Ltd., Baden, Switzerland; induction regulator enables voltage to be raised or lowered by 100 per cent from voltage in power line.

DESIGN. Electrothermal Processes, H. Moore. *Instn. Elec. Engrs.—Jl.*, vol. 69, no. 409, Jan. 1931, pp. 189-192. Technical advance in electric furnaces has been generally in improvement of detail and increase in size of unit; there is also marked tendency towards simplification of types; most significant advance has been rapid growth of high frequency induction furnace from small units melting few pounds of metal to furnaces melting up to one ton or more of steel in each charge.

ELECTRODE REGULATION. New Magnetic Hydraulic Electrode Regulator for Arc Furnaces, C. C. Loeb. *Iron Age*, vol. 127, no. 5, Jan. 29, 1931, p. 402-405, 3 figs. Sketches illustrate principles and operation of Tagliaferri regulator.

HIGH FREQUENCY. Typical Installations of Coreless Induction Furnaces, E. F. Northrup. *Iron Age*, vol. 127, no. 5, Jan. 29, 1931, pp. 395-399 and 447, 4 figs. Data on modern installations of coreless induction furnace for melting steel; usefulness as refining furnace and

as ladle; views as to future of industrial melting. Bibliography.

Power Problems in High-Frequency Melting, E. F. Northrup. *Iron Age*, vol. 127, no. 4,, Jan. 22, 1931, pp. 318-332 and 367-368, 14 figs. Reliability and life of furnace and electric equipment; factors controlling melting efficiency and results obtained from specific installations in superheating gray iron and making different varieties of alloy steel; data on control of stirring effects.

INDUCTION. The Coreless Induction Furnace in a New Role, A. G. Robiette. *Iron and Steel Industry*, vol. 4, no. 4, Jan. 1931, pp. 125-129, 4 figs. Review of possibilities of this furnace as refining appliance; data on furnace linings; carbon removal; dephosphorization; oxidizing with ore while melting; economies of induction steelmaking.

REFRACTORY MATERIALS. Refractory Materials for Electric Furnaces, A. B. Searle. *Metal Industry* (*Lond.*), vol. 38, no. 1, Jan. 2, 1931, pp. 3-4. Melting of lead and its alloys including type of metal, babbitt metal, and solder; temperature considerations; types of brick; shapes of bricks for lining; furnace roof.

Electric Measurements

REACTIVE POWER. Méthode de mesure de l'énergie électrique (Method of Measurement of Electric Energy), N. Koppel. *Industrie Electrique*, vol. 40, no. 925, Jan. 10, 1931, pp. 14-15, 5 figs. Method outlined allows for measurement of reactive power with ordinary calibration watt-hour meter.

Elevators

ELECTRIC. Operating Two Elevator Cars in One Hoistway, H. D. James. *Power*, vol. 73, no. 3, Jan. 20, 1931, pp. 100-103, 8 figs. In first commercial installation of its kind, two cars run on same guide rails, with another set of guide rails for counterweights; each elevator car in office building of Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa., rated at 3,000 lb. at 600 ft. per min.; floor-button system of control and full-automatic operation; design and operating characteristics; plan and elevation views of hoistways.

High-Speed Lifts, R. E. Hopkins. *Elec. Rev.*, vol. 108, no. 2773, Jan. 16, 1931, pp. 95-96, 2 figs. Review of two-speed problem on polyphase supply systems, with special reference to two-speed slip-ring "Equistop" motor.

Fuses

DESIGN. Rechnerische Bestimmung der Strom-Zeit-Kurve und des Grenzstromes; Beitrag zur Frage traeger Sicherungen (Numerical Determination of Current-Time Curve and of Limiting Current; Contribution to Problem of Slow-Acting Fuses), H. Vollhardt. *Elektrotechnische Zeit.*, vol. 52, no. 2, Jan. 8, 1931, pp. 37-40, 6 figs. Simple rule for graphical differentiation of exponential curves developed and correctness mathematically proven.

Mathematical Investigation of the Practical Formula on the Fusion of Fuse, Y. Ikeda and K. Yoneta. *Hokkaido Imperial University—Faculty of Eng.*—Memoirs, vol. 2, no. 5, Dec. 1930, pp. 147-159, 3 figs. Theoretical mathematical analysis. (In English).

Gases

ELECTRIC DISCHARGE. Les particularités de la décharge électrique dans les gaz rares, au point de vue de leur application a l'éclairage (Particularities of Electric Discharge in Rare Gases Considered from Standpoint of their Application in Lighting Practice), M. Laporte. *Revue Générale des Sciences*, vol. 41, no. 19, Oct. 15, 1930, pp. 543-548, 2 figs.; see also *Genie Civil*, vol. 98, no. 4, Jan. 24, 1931, p. 95, 2 figs. Contents of rare gases in air; chemical and electric considerations for use of rare gases; process in purification from lighting standpoint; spectrum of neon is most important because of its richness of red, orange and yellow rays.

Generators

WATER WHEEL. 20,000-Kva. Water Wheel Alternators, S. Neville. *Metropolitan-Vickers Gaz.*, vol. 12, no. 213, Jan. 1931, pp. 286-291, 10 figs. Two machines constructed and installed by Metropolitan Vickers Co., as initial generating plant of Waikaremoana hydroelectric power station of New Zealand have normal rating of 20,000 kva. at 0.8 power factor and are designed to B.E.S.A. specification no. 169 which provides for overload capacity of 25 per cent for two hours they have also 2 hr. rating of 25,000 kva. at 428 r.p.m.

Hoists

CONTROL. Automatic Control of Skip Hoists. *Elec. Times*, nol. 79, no. 2047, Jan. 15, 1931, pp. 119-120, 3 figs. Special features of Brookhirst switchgear equipment; comprising automatic motor starter of solenoid type, contactor type main and reversing switch, overload protective devices and isolating switch for preventing possibility of contact with "live" parts.

Hunting

SYNCHRONOUS MACHINES. Contribution a l'étude des oscillations d'un alternateur ou moteur synchrone (Study of Oscillations of Alternator or Synchronous Motor), F. Margand. *Société Francaise des Electriciens—Bul.*, vol. 10, no. 112, Dec. 1930, pp. 1302-1339, 11 figs. General equations of three-phase machine in variable condition; summary of equations for permanent state; equations for small movements around permanent state, oscillation of synchronous machine with constant excitation, etc.; theoretical mathematical analysis.

Hydroelectric

POWER PLANTS. Load and Plant Factors S. L. Kerr. *Power Plant Eng.*, vol. 35, no. 4, Feb. 15, 1931, pp. 258-260, 4 figs. Influence on operation economy; economic loading of water turbines; seasonal variation and load regulation; test efficiency compared with over-all plant efficiency corrected for gate leakage.

Insulating Materials

PAPER. Uses of Paper in Electrical Apparatus, W. H. Anderson. *Elec. Jl.*, vol. 28, no. 2, Feb. 1931, pp. 99-103, 10 figs. In manufacture of condensers paper is very thin kraft or linen tissue; somewhat heavier paper is now being wound on fine magnet wires in place of customary cotton covering; this application, though new, promises to become extensive; another class of paper generally used throughout electrical industry is for slot cell insulation in motors and generators.

TESTING ELECTRODES. Die Ausbildung von Pruefelektroden nach Rogowski (Defining Form of Rogowski Test Electrodes), C. Stoerk. *Elektrotechnische Zeit.*, vol. 52, no. 2, Jan. 8, 1931, pp. 43-45, 1 fig. For measurements and experiments on insulating materials, form of electrode as proposed by Rogowski is often recommendable; line of reasoning is given by which electrodes can be selected; graph from which form can be deduced.

Insulation

RESEARCH. Still a Long Way to Go in the Study of Insulation, W. P. Dobson. *Elec. News*, vol. 40, no. 3, Feb. 1, 1931, pp. 83-84. Research divided into three classes; first is designated "fundamental research" having as its object discovery of properties and laws of insulation based upon fundamental properties of matter; second, embraces those studies which aim to use fundamental research to build ups empirical formulas applicable to design of insulation; third division, includes practical problems of design, improvement in materials and methods of application.

Lamps

GLOW. A Three-Element Glow Lamp for Sound Recording, V. T. Braman. *Projection Eng.*, vol. 3, no. 1, Jan. 1931, pp. 19-20, 2 figs. Employment of third element in glow lamps overcomes certain difficulties heretofore experienced in sound recording.

ULTRA VIOLET. Ultraviolet Radiation from the Sunlight (Type S-1) Lamp, A. H. Taylor. *Optical Soc. Am.—Jl.*, vol. 21, no. 1, Jan. 1931, pp. 20-29, 6 figs. Sunlight (Type S-1) lamp introduced in fall of 1929 as affording means of dual purpose lighting, combining light for vision and radiation for health maintenance; electrical characteristics; spectral energy characteristics; energy distribution; operating conditions; instruments and methods of measurement; grapical representations of data; effect of blackening of bulb.

Lighting

CODES. Code of Street Lighting. *Illum. Eng. Soc.—Trans.*, vol, 26, no. 1, Jan. 1931, pp. 15-35 and (discussion) 35-38, 1 fig. Code covers status and purposes of street lighting; visibility under street lighting conditions; lighting fundamentals; classification of streets; recommended practise for light traffic, medium traffic, and heavy traffic thoroughfares, business districts, alleys, and highways.

Lines

CONSTRUCTION. Line Construction Organization Methods. *Nat. Elec. Light Assn. —Report*, no. 111, Jan. 1931, 7 pp. Policies of several representative operating companies on various phases of line construction organization and efficiency methods are reviewed; present practise in purchase of hand tools and use of power operated tools in roofing, gaining, and boring poles are analyzed; study of line crew personnel and educational methods.

SWITCHES. Pole-Top Switches Redesigned for All-Wood Construction, F. E. Andrews. *Elec. World*, vol. 97, no. 5, Jan. 31, 1931, p. 226, 2 figs. Following adoption of all wood 33-kv. line construction on system of Public Service Company of Northern Illinois problem arose in design of pole-top switches for use on these lines; with cooperation of several switch manufacturers pole-top switches have been designed in conformity with new line construction. Before Nat. Elec. Light Assn.

GROUND DETECTORS. Neon Tubes Make Inexpensive Ground Detector, H. P. Currin. *Elec. World*, vol. 97, no. 2, Jan. 10, 1931, p. 110, 1 fig. Short sections of neon tubes with porcelain insulators for supplying exciting current proved quite satisfactory in 2,400-volt detector system.

VOLTAGE CONTROL. Voltage Surveys and How They Are Made, E. S. Lincoln. *Indus. Eng.*, vol. 89, no. 1, Jan. 1931, pp. 20-23, 5 figs. Importance of proper voltage maintenance in electrical apparatus; effect of voltage variation in following equipment; d-c. and synchronous motors, heating apparatus, and lighting system; low-voltage and single-phase or three-wires d-c. systems of voltage surveys.

HIGH TENSION — DESIGN. Calcul mécanique des conducteurs et de la tension de pose des lignes a très haute tension (Mechanical Strength Calculation for High-Tension Transmission Lines), H. Roux. *Electricien*, vol. 62, no. 1507, Jan. 1, 1931, pp. 2-6, 5 figs. Equations and curves for calculation of span, sag, stresses, etc.

PROTECTION. Safeguards for Low-Voltage Electrical Supply, H. C. Graves and J. A. C. Krips. *Power Plant Eng.*, vol. 35, no. 3, Feb. 1, 1931, pp. 210-213, 7 figs. Dual power sources, automatic transfer and protected circuit breakers, time limits, convenient inspection and repair; remote control and removable breakers overcome previous limitations.

Lighting

CAR. Electric Train-Lighting Equipment, C. Coppock. *Ry. Engr.*, vol. 52, no. 612, Jan. 1931, pp. 37-40, 8 figs. Design, construction, and operating features of equipment manufactured by J. Stone and Co.; wiring diagrams. (Continuation of serial.)

Loud Speakers

Some Measurements of Loud-Speaker in Vacuo, P. K. Turner. *Instn. Elec. Engrs.—Advance Paper*, Jan. 19, 1931, 20 pp., 18 figs. Electrical impedance of moving-coil loudspeaker is measured with coil held fast with coil free, but in vacuo; under normal conditions; from basic analysis of this type of instrument, which is given briefly, it follows that this series of measurements should allow sufficient separation of its various characteristics to lead to possibility of estimating its actual performance.

Magnetic Units

La question du "gauss" (The Problem of the "Gauss"), C. O. Mailloux. *Revue Générale de l'Electricité*, vol. 29, no. 4, Jan. 24, 1931, pp. 125-132. International Electrical Commission has introduced "Oersted" as C. G. S. unit of electric field in order to end differing conceptions of Gauss unit in United States, Great Britain and other countries; author who has taken active part in 1900 in discussions at American Institute Electrical Engineers and Electricity Congress in Paris, where Gauss unit was accepted, discusses correctness of decision of International Commission.

Measuring Instruments

Electrical Measuring Instruments Other Than Integrating Meters, C. V. Drysdale. *Instn. Elec. Engrs.—Jl.*, vol. 69, no. 409, Jan. 1931, pp. 170-178. Principal items of progress since appearance of last review in June, 1928, have been development of instrument transformers with nickel-iron cores; improvement of soft iron instruments; more general employment of spring supported pivots or jewels; adaption of thermocouples and copper-oxide rectifiers to permanent magnet instruments; introduction of new forms of a-c. potentiometers; application of photoelectric cells to photometry.

Mechanical Stresses

FIXED CONDUCTORS. Phénomènes electrodynamiques dus aux courants intenses dans l'appareillage (Electrodynamic Phenomena Due to Strong Currents in Equipment), C. Bresson. *Revue Générale de l'Electricité*, vol. 29, no. 1, Jan. 3, 1931, pp. 13-30, 24 figs. Summary of basic formulas necessary for calculation of dynamic stresses resulting from conductors in defined positions; development for practical use in design of electric apparatus and equipment as to mechanical strength with respect to short-circuit effects.

Motors

RAILROAD. Le moteur de traction a courant continu en service sour tension ondulée (Direct Current Traction Motors Operating on Pulsating Voltage), K. Toefflinger. *Revue Générale de l'Electricité*, vol. 29, no. 3, Jan. 17, 1931, pp. 105-112, 7 figs. Effect of rectified current on operation of motor can be satisfactory if certain precautions are taken; means to be applied are discussed.

Compound Motors Tested on Two French Systems. *Elec. Ry. Jl.*, vol. 75, no. 2, Feb. 1931, pp. 92-93. System developed by Lievre, of Marseilles, using compound motors with series-parallel control and regeneration, shows savings of 30 per cent from similar equipment with series motors.

SYNCHRONOUS. Simplex Synchronous Motor, M. A. Hyde. *Elec. Jl.*, vol. 28, no. 2, Feb. 1931, pp. 77-80, 6 figs. Simplex synchronous motor delivers both high starting and pull-in torque with low starting current and without use of any mechanical loading device.

Networks

ALTERNATING CURRENT. Design of Secondary Distribution Systems, V. W. Palen. *Power Plant Eng.*, vol. 35, no. 4, Feb. 15, 1931, pp. 264-267, 9 figs. Economic secondary design for single-phase system serving city of about 120,000; design data and calculations. (To be continued.)

CALCULATION BOARDS. The A-C. Calculating Board Simplifies System Design, W. W. Parker. *Elec. Light and Power*, vol. 9, no. 2, Feb. 1931, pp. 28-29, 2 figs. Demand for calculating board which would accurately take into account phase angle considerations in solution of networks for relay applications and for study of voltage regulation, load control, and stability has been met by Westinghouse Company; equipment is described.

LOAD ANALYSIS. A Few Operating Characteristics of Domestic Motors, Radio Sets and Neon Signs, A. W. Murdock. *Hydro-Electric Power Commission Ont.—Bul.*, vol. 18, no. 1, Jan. 1931, pp. 16-22, 2 figs. Attempt to analyze characteristics from two angles, namely, effect of equipment on distribution system, and effect of irregularities in system on equipment. Before Assn. Mun. Elec. Utilities.

PLANNING. System Planning for Economic Distribution Substations. *Elec. News*, vol. 40, no. 2, Jan. 15, 1931, pp. 45-46. Supplementing "A Master Plan for Sound Growth in System Expansion," previously indexed in Jan. 1, 1931 issue; article covers economic considerations necessary for establishment of new or future distribution substations; no general rules can be applied, but every factor should be allotted its true weight to arrive at best balance. From report of Nat. Elec. Light Assn.

SHORT CIRCUITS. Méthode rapide, semi-expérimentale, pour la détermination du courant de cour-circuit permanens dans un réseau quelconque (Quick Semi-Experimental Method for Determination of Permanent Short-Circuit in Any Kind of Network), G. Crivalleri. *Houille Blanche*, vol. 29, no. 167-168, Nov.-Dec. 1930, pp. 174-179, 2 figs. Method is outlined, curves for calculation are given. (To be continued.)

Oil

ACIDITY. Potentiometric Determination of Acidity in Insulating Oils, R. N. Evans and J. E. Davenport. *Indus. and Eng. Chem.—Analytical Edition*, vol. 3, no. 1, Jan. 15, 1931, pp. 82-85, 7 figs. Estimation of acidity in oils employing alkali blue procedure has been found to give more satisfactory results than A.S.T.M. procedure; in latter method, methyl alcohol should not be substituted for ethyl alcohol; electrometric titrations have been carried out on type organic acids successfully.

Paper Mills

ELECTRIC EQUIPMENT. Installation Electrique de l'Usine de Bellegarde (Ain) de la Société Anonyme des Papeteries Darblay (Electric Installation of Bellegarde Plant of the Darblay Paper Co.), A. Perrin. *Revue d'Electricité et de Mécanique*, no. 14, Nov.-Dec. 1930, pp. 19-25, 9 figs. Supply from substation at 8,000 volt, 50 cycles, transformed over seven 800-kva. transformers to 1,000 volt; drive takes place from induction motors of 240 volt ranging from 120- to 800-hp.; equipment and machinery described and specified.

Photoelectric Cells

Der heutige Stand der Forschung auf dem Gebiete der lichtelektrischen Zellen im besonderen Hinblick auf deren technische Anwendungen (Present Status of Research on Photo Electric Cells with Special Regard to Practical Application), Schroeter. *Metallboerse*, vol. 20, no. 103, Dec. 24, 1930, pp. 2805-2806. Physical fundamentals of internal photo effect, variation of conductivity, external photo effect, separation of electrons from surfaces, photo effect in gases, and variation of charging resistance; for practical application essentially exterior photo effect is of value.

Poles

PRESERVATION. New Treatment for Preserving Poles, F. S. Shinn. *Telephony*, vol. 100, no. 3, Jan. 17, 1931, p. 33. Extensive research work carried on for purpose of developing new wood preservative; zinc meta arsenite (ZMA) found to be most practical. Address before Annual convention, Ill. Telephone Assn.

Potentiometers

GLASS ELECTRODE. The Glass Electrode and Vacuum Tube Potentiometers, D. H. Cameron. *Am. Leather Chemist Assn.—Jl.*, vol. 26, no. 1, Jan. 1931, pp. 7-23. Description, disadvantages and use of glass electrode for pH determinations.

Power Factor

The Power Factor Problem. *Elec. Engr. of Australia and New Zealand*, vol. 7, no. 9, Dec. 15, 1930, pp. 327-328, 1 fig. Savings that can be made by correction; economics of situation.

Power Supply

BUILDINGS. Electric Service for Hotels and Office Buildings. *Nat. Elec. Light Assn.—Report*, no. 112, Jan. 1931, 28 pp., 27 figs. Compiled information on use of electric service to serve as guide for engineers, architects and owners of such buildings or buildings of similar character, in selecting source of electric service; report generalizes on application of purchased electric service and brings out its tangible and intangible advantages.

CAR RETARDERS. New Haven Develops Unique Power Supply for Retarders at Providence Yard, W. F. Follett. *Ry. Signaling*, vol. 89, no. 1, Jan. 1931, pp. 11-12 and 14, 4 figs. Special motor-generator in combination with storage battery reduces power consumption to 30 watts per classified car when yard is being operated at capacity; importance of automatic switching.

Radio

AERIAL TRANSPORTATION. Port and Pilot Communication by Radio Telephone, A. E. Brundage. *Airports*, vol. 6, no. 2, Feb. 1931, pp. 11-13, 3 figs. Advantages of two-way communication between plane and airport, and available equipment; map shows air transport lines equipped with radio telephone.

AMPLIFIERS. Audio Compensated Amplifier for Broadcasting and Recording Studios, J. G. Aceves. *Radio Eng.*, vol. 11, no. 1, Jan. 1931, pp. 37-38, 5 figs. New audio amplifier system which permits of compensating for improper room acoustics and for loudspeaker deficiencies.

BATTERIES. Wireless; The Real Problem, S. T. Wallace. *Telegraph and Telephone Jl.*, vol. 17, no. 190, Jan. 1931, pp. 75-76. Problem of various batteries used in radio receivers; some may consider that all-electric operation is ultimate solution to difficulty, but for present discussion this can be dismissed; it is very long way off for great majority and in many directions it has its own peculiar difficulties, evidenced even in progressively electric America, where battery operated receivers are still very much to fore; there is occasional talk of cold tubes; they are not urgently required; infinitely more pressing problem is abolition of need for high voltages.

CONDENSERS, ELECTROLYTIC. Electrolytic Condensers — Characteristics and Methods of Measurement, W. L. Dunn. *Radio Eng.*, vol. 11, no. 1, Jan. 1931, pp. 31-33, 4 figs. Engineering presentation of true action and performance of electrolytic condensers used in radio receivers.

Characteristics of Dry-Electrolyte Condensers, H. Ross. *Radio Eng.*, vol. 10, no. 12, Dec. 1930, pp. 27-28. Laboratory examination of dry-electrolyte condensers show characteristics for radio receiver operation.

FREQUENCY METERS. Ein einfacher Frequenzmesser hoher Genauigkeit (Simple Frequency Meter of High Degree of Exactness), H. Piesch. *Zeit. fuer Hochfrequenztechnik*, vol. 36, no. 6, Dec. 1930, pp. 211-217, 5 figs. Review of existing types, calibration standards; measuring equipment over wide range of frequency, absorption wave meter, performance, theoretical fundamentals, application of phenomena for measuring purposes, description of measuring arrangement with absorption circuit. Bibliography.

GENERATORS. Motor Generators, Dynamotors, and Rotary Converters for Radio Uses, E. W. Berry. *Radio Eng.*, vol. 10, no. 12, Dec. 1930, pp. 44, and 46, 1 fig. Field for a-c. tube receivers extended by installation of machine converters; types of units are described.

MEASURING INSTRUMENTS. Rectifier Type Instruments, W. N. Goodwin, Jr. *Radio Eng.*, vol. 10, no. 12, Dec. 1930, pp. 34-35, 1 fig. Practical method of measuring alternating currents of low e. m. f.'s; construction; principle of operation; accuracy; temperature errors; frequency errors; errors due to change in current density; wave form errors.

MEASUREMENTS. Common Difficulties in Receiver Measurements, R. P. Glover. *Radio Eng.*, vol. 10, no. 12, Dec. 1930, pp. 42-43, 3 figs. Dissemination of incorrect data on receiver performance causes serious servicing difficulties; method of receiver measurement; characteristics of tubes and need for tubes having average characteristics.

REMOTE CONTROL. Mechanical Remote Tuning Controls for Radio Receivers, J. C. Smack. *Radio Eng.*, vol. 11, no. 1, Jan. 1931, pp. 28-30, 5 figs. Method of solving problem of remote tuning control for broadcast and airplane radio receivers is outlined.

SHORT WAVE. Short-Wave Receiver Design, A. Binneweg, Jr. *Radio Eng.*, vol. 11, no. 1, Jan. 1931, pp. 26-27, and 30, 3 figs. Regenerative detector short-wave receiver design with experimental results, are considered; with slight change in circuit constants, operation is greatly improved.

SHORT WAVE. A Superheterodyne Receiver for Short Waves, R. W. Tanner. *Radio Eng.*, vol. 11, no. 1, Jan. 1931, pp. 22-23, 1 fig. Oscillator tuned system for high frequency radio reception, giving stable operation is described.

Railroad

ELECTRIFICATION. Railroad Electrification Brings Economies, H. L. Andrews. *Elec. World*, vol. 97, no. 3, Jan. 17, 1931, pp. 153-155, 3 figs. Pennsylvania and Reading, using 11,000 volt, 25 cycle a-c. system are outstanding for fact that initial suburban electrifications is integral part of extensive project in main line electrification; Delaware, Lackawanna & Western is initial suburban project in this country to utilize 3,000-volt d-c. system for multiple unit cars and is first steam railroad operation of any magnitude in world to rely entirely on 3,000-volt mercury arc rectifiers as conversion units; curves and tables showing economy of operation. Presented before New York Railroad Club.

SIGNALS — CENTRAL CONTROL. Results of Centralized Control on N.Y.C., J. J. Brinkworth. *Ry. Signaling*, vol. 24, no. 2, Feb. 1931, p. 52. Review of improvements in train operation effected by centralized traffic control system. Before New England Railroad Club.

SIGNALS—INTERLOCKING. Canadian Pacific Utilizes Modern Interlocking to Protect Movable Bridge, E. S. Taylor. *Ry. Signaling*, vol. 24, no. 1, Jan. 1931, pp. 24-25, 7 figs. Design and operating features of signals and signaling system employed between Sault Ste. Marie, Ont., and Sault Ste. Marie, Mich.; two-lever table interlocking machine controls bridges.

TRAIN CONTROL. Annual Report of Bureau of Safety on Signals and Train Control. *Ry. Signaling*, vol. 24, no. 1, Jan. 1931, pp. 21-23. Abstract of report by Bureau of Safety of Interstate Commerce Commission for fiscal year ending June 30, 1930; special investigations; accidents in train-control territory.

Rectifier

VACUUM TUBES. Ein gasgefuellter Kleingleichrichter mit Oxydgluehkathode (Gas-filled Small Capacity Rectifiers with Oxide Coated Incandescent Filament), M. Knoll. *Elektrotechnische Zeit.*, vol. 52, no. 3, Jan. 15, 1931, pp. 65-68, 8 figs. New types of full-wave rectifier tubes with oxide filament and argon filling of which small dimensions provide for inexpensive manufacture and long life; oscillographic testing.

Refrigeration

ELECTRIC MOTORS. The Patent Situation in Enclosed Motor Refrigeration, H. R. Van Deventer. *Refrig. Eng.*, vol. 21, no. 1, Jan. 1931, pp. 29-32, 18 figs. Term "enclosed motor" as applied to refrigerating machines has been commonly applied to unitary motors and compressors enclosed in hermetically sealed chamber; advantages and disadvantages of arrangement; résumé of patent situation.

Rotors

Coil Support Insulation for Rotor Banding, A. C. Roe. *Indus. Eng.*, vol. 89, no. 1, Jan. 1931, pp. 33-35, 9 figs. Practical discussion of coil supports, materials and methods used to prepare them to receive winding and retaining bands.

Signals

MINES. Underground Signaling with A-C. Circuits, G. Allsop. *Colliery Guardian*, vol. 142, no. 3657, Jan. 30, 1931, pp. 393-394, 2 figs.; see also *Iron and Coal Trades Rev.*, vol. 122, no. 3283, Jan. 30, 1931, p. 217, 2 figs. Suggested methods for signaling, to guard against open sparking; necessity of closing and opening bell circuit has been eliminated by employing choke-coil to vary current through system. Abstract of paper read before Midland Inst. Min. Engrs.

Spark Gaps

CALIBRATION. Sphere-Gap Calibration, S. Whitehead and A. P. Castellain. *Instn. Elec. Engrs.—Advance Paper*, received July 22, 1930, 24 pp., 24 figs. Experiments carried out at East London College upon spark over between spheres and standardization of sphere-gap as voltmeter; origin and objects of research; methods employed in measuring high voltages.

Substations

INDUSTRIAL. Substation Standardized for Small Industrials. *Elec. World*, vol. 97, no. 2, Jan. 10, p. 103, 1 fig. Typical of equipment and arrangement adopted for loop tie-in substations for relatively small industrial customers is 22-kv. Stubenville coal and mining station of Ohio Power Company; airbreak switches are installed on line sides of tap connections leading to transformers and protective equipment, and switches of this type also are interposed in advance of delta-connected transformers; station surrounded by protective industrial wire fence is used for capacities up to 1,000 kva.

REMOTE CONTROL. Midworth Distant Repeater Equipment for Electric Substation Control. *Ry. Gaz.*, vol. 54, no. 1, Jan. 2, 1931, pp. 19-20, 1 fig. System installed on Manchester, South Junction and Altrincham Railway, enabling complete control of Timperley substation maintained from Old Trafford main substation; diagram showing general arrangement of Midworth distant repeater installation; system operation.

Telephone

AUTOMATIC. Problems in Automatic Trunking—Last Contact Traffic, N. A. Hawkins *Post Office Elec. Engrs. Jl.*, vol. 23, pt. 4, Jan. 1931, pp. 272-281, 5 figs. Theoretical considerations of case of full availability and of case of grading; practical applications with examples.

CARRIER CURRENT. Full Description of Type C Carrier System, F. J. Dommerque. *Telephone Engr.*, vol. 35, no. 1, Jan. 1931, pp. 22-24, 5 figs. System accommodates three carrier channels in addition to voice current channel.

ECHO SUPPRESSORS. The New Standard Echo Suppressor, W. F. Marriage, P. R. Thomas and K. G. Hodgson. *Elec. Communication*, vol. 9, no. 3, Jan. 1931, pp. 196-202, 9 figs. International Telephone and Telegraph Laboratories have developed new type of valve echo suppressor which has been standardized by International Standard Electric Corp. and which operates entirely without moving parts and is therefore very reliable and easy to maintain.

PERFORMANCE. Rating the Transmission Performance of Telephone Circuits, W. H. Martin. *Bell System Tech. Jl.*, vol. 10, no. 1, Jan. 1931, pp. 116-131, 1 fig. Rating is discussed on basis of rate of repetitions in telephone conversations; rating method set up on this basis is being adopted in Bell System for determining and expressing data for transmission design of telephone plant.

REPEATERS. Step-by-Step Pulse Repeater P. T. Slattery. *Bell Laboratories Rec.*, vol. 9, no. 5, Jan. 1931, pp. 238-240, 3 figs. Necessity to provide some means of relaying dial, pulses at originating office is met by use of apparatus capable of receiving pulses from subscriber's dial and sending out new ones which will successfully operate switches in distant office, known as pulse repeater; various pulse repeating circuits.

Television

Progress in Two-Way Television, H. E. Ives. *Bell Laboratories Rec.*, vol. 9, no. 6, Feb. 1931, pp. 262-264, 4 figs. Optical features, which make received image quite appreciably more life-like than it appeared with any of earlier apparatus.

MULTI-CHANNEL. A Multi-Channel Television Apparatus, H. E. Ives. *Optical Soc. Am.—Jl.*, vol. 21, no. 1, Jan. 1931, pp. 8-19, 5 figs. Method developed provides image of many-fold more image elements than heretofore, and may make easier problem of transmission over practical transmission lines; three-channel apparatus; three-electrode neon lamp used; discussion of results.

SYNCHRONIZATION. Die Synchronisierung von Fernsehempfangs-Apparaten, Insbesondere bei Verwendung der Braunschen Roehre (Synchronization of Television Receiving Apparatus with Special Regard to Application of Braun's Tube), E. Hudec. *Fernsehen*, vol. 2, no. 1, Jan. 1931, pp. 14-28, 15 figs. It is shown that perfect synchronism between image-composing and image-dissecting equipment only then is possible, when special synchronizing current is generated at receiver which is completely separated from image current.

Testing Apparatus

High-Voltage Testing Equipments, E. T. Norris and F. W. Taylor. *Instn. Elec. Engrs.—Advance Paper*, received Dec. 16, 1930, 22 pp., 26 figs. Paper describes numerous classes of apparatus available for production of high voltages for testing and experimental purposes and discussed installation and operation of complete testing equipments for various specialized requirements.

Trackless Trolleys

Trolley Bus Costs and Advantages Compared With Other Vehicles, E. H. Lamberger. *Elec. Traction*, vol. 27, no. 1, Jan. 1931, pp. 28-31, 4 figs. Advantages and disadvantages of electric, gas-electric and gas-mechanical buses; curves indicating acceleration characteristics of three types of buses; relative schedule speed characteristics of three types of buses, average engine speed of gas-electric and gas-mechanical vehicles, and power costs; table of comparative investment and operating data between trolley bus, gas-electric and mechanical vehicles.

Trolley Bus Experiences Unprecedented Growth During Past Year, C. A. Faust. *Elec. Ry. Jl.*, vol. 75, no. 1, Jan. 1931, pp. 45-48, 5 figs. Five new installations add 105 vehicles and 34.90 route mi.; with additions of 11 trolleys buses and 7.36 mi. by systems already in operation totals for industry rise to 182 vehicles and 70.05 mi.; present trolley-bus operations in United States and its possessions; table of trolley buses ordered by electric railways during 1930, totaling 116.

Transformers

DESIGN. Transformer Design, E. T. Norris. *Elec. Rev.*, vol. 108, nos. 2774 and 2775, Jan. 23, 1931, pp. 140-142 and Jan. 30, pp. 182-184, 8 figs. Jan. 23: Investigation into methods of reducing stresses in windings resulting from high-voltage surges and steep-fronted traveling waves; initial distribution of surges; results of voltage oscillation; limitation of local stresses; electrostatic shields; maximum wave-length of surges. Jan. 20: Protection of windings against surges by means of external apparatus which reduces steepness of traveling waves.

DISTRIBUTION. Distribution Transformers, E. T. Norris. *Elecn.*, vol. 106, no. 2748, Jan. 30, 1931, pp. 162-163, 4 figs. Effect of lightning surges and line insulation on reliability test; location of failures.

GROUNDING. Buried Copper Grid Affords Uniform Ground. *Elec. World*, vol. 97, no. 6, Feb. 7, 1931, p. 286, 5 figs. System used to obtain fairly consistent ground current behavior by Oklahoma Gas & Electric Company.

RELAYS. Theory and Application of Relay Systems—Transformer Protection, P. H. Robinson and I. T. Monseth. *Elec. Jl.*, vol. 28, no. 2, Feb. 1931, pp. 111-116, 21 figs. In applying differential relays to transformers, ratio differential type rather than ordinary overload type of relay should be used; this results in form of protection which is sensitive to internal faults yet insensitive to short-circuit currents flowing through transformer and caused by external fault conditions.

TAP CHANGERS. Transformers Tap Changing on Load. *Engineer*, vol. 151, no. 3913, Jan. 9, 1931, pp. 58-59, 7 figs. New B. T. H. inexpensive and simple equipment, developed for use with transformers carrying but small current per phase, which at present can be used on transformers up to 6,000-kva. capacity and working on 33,000-volt systems, consists essentially of oil-immersed drum controller, fingers of which make contact on their segments in correct sequence as drum revolves.

Vacuum Tubes

TELEPHONE. Vacuum Tube Theory and Practise as Applied to the Telephone Circuit. *Telephone Engr.*, vol. 35, no. 1, Jan. 1931, pp. 36-38, 8 figs. Types; theory of operation; characteristic curves; constants; plate resistance; mutual conductance.

THYRATRON. Motor Control by Thyratron Tubes, A. G. Turnbull. *Elec. News*, vol. 40, no. 2, Jan. 15, 1931, pp. 64-65, 4 figs. Two examples, illustrating accurate control. point to no limit in application.

Voltmeters

NEON TUBE. The Construction and Operation of a Simple Neon-Tube High-Tension Crest Voltmeter, L. E. Ryall. *Instn. Elec. Engrs.—Advance Paper*, received July 4, 1930, 7 pp., 8 figs. Principles governing design of neon tube crest voltmeter; precautions necessary to secure reliable operation including selection of permanent neon lamp; 150-kv. (max.) crest voltmeter; and design of voltmeters for higher voltages.

Watt-Hour Meters

MAXIMUM LOAD. Hoechstleistungsmesser und ihre Messgenauigkeit (Maximum Load Meters and Their Exactness in Measuring), F. Bergtold. *Elektrische Betrieb*, vol. 29, no. 1, Jan. 15, 1931, pp. 1-5, 10 figs. Determination of maximum required load by means of watt-hour meter with special recording mechanism, performance of this equipment and possible errors in operation.

TESTING. Permanence of Rotating Standard Accuracy, G. E. Meredith *Elec. World*, vol. 97, no. 4, Jan. 24, 1931, p. 188, 1 fig. Out of 212 weekly tests on rotating standard purchased in 1924 by Kansas City Power & Light Co. and in continuous use since that year only 25 show accuracies "as found" above 100.5 or below 99.5 per cent. Before Nat. Elec. Light Assn.

Welding

BRIDGE CONSTRUCTION. Welding in Bridge Work. *Ry. Eng. and Maintenance*, vol. 27, no. 1, Jan. 1931, pp. 42-43, 1 fig. Bridge and Building Assn. considers application of electric welding steel structures; presentation of paper, strengthening a Bridge by Arc Welding Process, by W. R. Roof, and discussion.

CAST IRON. Pure-Iron Electrodes for Welding Cast Iron, H. D. Lloyd and J. S. G. Primrose. *Foundry Trade Jl.*, vol. 44, no. 752, Jan. 15, 1931, pp. 37-38. Effect of phosphide eutectic; mechanical strength of welds; burning-on; thermit process; metallic-arc method; soft-iron rods; welding gas-engine bedplate; fluxes used; danger zones; welding malleable castings. Abstract of paper read before Instn. Welding Engrs.

NICKEL STEEL. Abstract of Thesis on Arc Welding of Nickel Steel, T. K. McManus. *Am. Welding Soc.—Jl.*, vol. 10, no. 1, Jan. 1931, pp. 16-19, 5 figs. Welds in 3½ per cent nickel steel with commercial, chrome-nickel, aluminum-bronze, nickel-steel and chrome-molybdenum wire; tension, bend, impact and fatigue test of original and welded materials supplemented by *H*-ray examination; microphotographs illustrate crystal structure of welds.

PRESSURE VESSELS. Unfired Pressure Vessels, W. Spraragan. *Indus. and Eng. Chem.*, vol. 23, no. 2, Feb. 1931, pp. 220-226, 8 figs. Fundamental factors considered are: (1) selection of material of good welding quality and use of good welding wire; (2) correct design of vessel and welded joints; (3) use of qualified welders; (4) proper preparation of material for welding (5) employment of proper technic; and (6) testing of completed vessel.

Welding Machines

Resistance Butt Welding of Tools. *Welding Engr.*, vol. 16, no. 1, Jan. 1931, pp. 41-42, 5 figs. Design and performance of machines suited particularly for welding of drills and other precision tools.

AUTOMATIC. Automatic Arc Welding. *Engineer*, vol. 151, no. 3915, Jan. 23, 1931, p. 100, 5 figs. A. E. G. system of automatic arc welding was developed to improve upon welding by hand, which presents several well-known disadvantages; automatic machine can weld with higher current values and at greater speeds, while arc can be moved over work uniformly and be made to deposit metal smoothly and continuously; examples of A.E.G. welding machines and their application.

Industrial Notes

H. W. Clough Promoted.—The Belden Manufacturing Company, Chicago, announces the appointment of H. W. Clough as sales manager. Mr. Clough has been with the company for nine years and was previously manager of the Merchandise Division.

Joins Norma-Hoffmann Sales Force.—John W. Blackford, for the past 8 years with the Torrington Company and for the last two years manager of the Detroit office of the above company, has joined the sales organization of Norma-Hoffmann Bearings Corporation, Stamford, Conn.

Rockbestos Products Corporation, New Haven, Conn., manufacturers of electrical wires and cables for use under severe conditions, announces the appointment of Malcolm T. Ritchie as New England territory salesman; the addition to its Pittsburgh sales office of Carleton W. Fletcher, formerly of the main office, and the addition of Philip O. Weston to the home office sales promotion staff.

The General Electric Company, Schenectady, N. Y., has disposed of its trolley line material business to the Ohio Brass Company of Mansfield, Ohio. This includes overhead materials for electric railways, electrified mines, industrial haulage, and electrified steam roads,—a field in which the Ohio Brass Company has specialized quite intensively for many years. This transaction is relatively of small importance because of the volume of business involved, and although of some advantage to both companies, it is principally of benefit to the users of this class of material.

The Daven Company, successors to The Daven Radio Corporation, manufacturers of Super-Davohm wire wound precision resistors, 158-160 Summit Street, Newark, New Jersey, announces the purchase of the Superior Resistor Corporation recently located at 334 Badger Avenue, Newark. The entire equipment of the former Superior Resistor Corporation has been moved and assembled at the Daven plant. With this addition in machinery and equipment The Daven Company has increased its production capacity over 25 per cent. The Daven Company will retain the trade name "Super-Ohm" in addition to their present trade names "Super-Davohm" and "Davohm."

General Electric Annual Report.—Despite the general depression in business, General Electric had a fairly successful year in 1930, with earnings greatest in the history of the company, except for 1929, Gerard Swope, president, disclosed in the annual report of the company recently made public.

Orders received during 1930 amounted to $341,820,312, compared with $445,802,519 in 1929, a decrease of 23 per cent, and unfilled orders at the end of the year totalled $56,062,000, compared with $94,623,000 at the close of 1929, a decrease of 41 per cent. Sales billed for 1930 were $376,167,428, compared with $415,338,094 in 1929, a decrease of 9½ per cent. Net income from sales in 1930 amounted to $40,450,261, which, compared with $49,395,896 in 1929, shows a decrease of 18 per cent. These figures for 1930 do not include radio set and tube business, which was transferred to the Radio Corporation of America on January 1, 1930, except that derived from General Electric radios, which were introduced the latter part of the year.

The average number of employees during 1930, not including those of associated companies, was 78,380, compared with 87,933 in 1929. The total earnings of these employees were $140,905,000 and $163,090,000, and average annual earnings were $1,798 and $1,855 respectively.

Recent Westinghouse Orders.—As a part of the electrical equipment for one of the largest electro metallurgical plants in the world, the Westinghouse Electric & Manufacturing Company has received from the Electro Metallurgical Company, an order amounting to approximately $100,000 for six 5,000 kva. transformers to supply power to electric furnaces. The new plant, which will be at Boncar, West Virginia, is being constructed by the Electro Metallurgical Company, a subsidiary of the Union Carbide & Carbon Corporation.

Other recent orders include the electrical equipment for five 400-hp. gas electric cars to be used on the Santa Fe Railroad. These cars will be duplicates of four others ordered by the same company in 1929. The Westinghouse Electric International Company has been awarded a contract for twelve circuit breakers by Ryobi Denki Shokai, of Japan, for use in the Tokyo district.

An order in excess of $500,000 has been received from the Navy Department for the main propelling machinery and engine room auxiliaries for a new 10,000-ton Treaty cruiser. The new vessel, designated as No. 38, is yet unnamed and will be built at the Mare Island Yard, California. Her four main geared-turbines will deliver a shaft horsepower of 107,000, giving the vessel a speed of 33 knots. The electrical equipment will be a duplicate of that ordered for cruisers 37, 34, and 36, all being for Westinghouse machinery.

The Brooklyn Edison Company has ordered sixteen 1,000-hp. electric motors to be installed in the Hudson Avenue Generating Station as a part of the auxiliary equipment for units in that station.

Trade Literature

Instruments.—Catalog 211, 188 pp. Describes Westinghouse instruments, relays and electronic devices. Westinghouse Electric & Manufacturing Company, East Pittsburgh.

Electric CO_2 Meters.—Catalog 3004, 32 pp. Describes Brown CO_2 indicating and recording meters used in furnace operation. The Brown Instrument Company, Philadelphia.

Carrier-Current Telephone Equipment.—Bulletin GEA-1354, 8 pp. Describes type KCA-400 carrier current telephone equipment for patrol and unattended-substation use. General Electric Company, Schenectady, N. Y.

Lightning Arresters.—Bulletin 1, 20 pp. Describes the process of manufacture of crystal valve lightning arresters. This booklet is the first of a series. Electric Service Supplies Company, 17th & Cambria Streets, Philadelphia.

Oil Drier and Filter.—Bulletin GEA-1333, 4 pp. Describes the G-E transformer-oil drier and filter for removing moisture and other foreign material from insulating oil in order to restore its dielectric strength. General Electric Company, Schenectady, N. Y.

Industrial Control.—Catalog 5016, 24 pp. Describes Condit air circuit breakers, oil switches and circuit breakers, air and oil motor starters and service switches. Condit Electrical Manufacturing Corp., Hyde Park Station, Boston.

Heavy - Duty Test Sets.—Bulletin 1133, 4 pp. Describes special transformers and test sets for heavy-duty testing at high voltages. The units covered range in size from 2 to 500 kva., and are built for potentials from 10,000 volts to 300,000 volts. American Transformer Co., 177 Emmet Street, Newark, N. J.

Portable Oil Test Set.—Bulletin 1132, 2 pp. Describes a portable set for making accurate dielectric strength tests on transformer oil. The unit operates from 110-volt, 60-cycle circuits and develops potentials up to 30 kv. It is equipped with a voltmeter, circuit breaker and potentiometer. American Transformer Co., 177 Emmet St., Newark, N. J.

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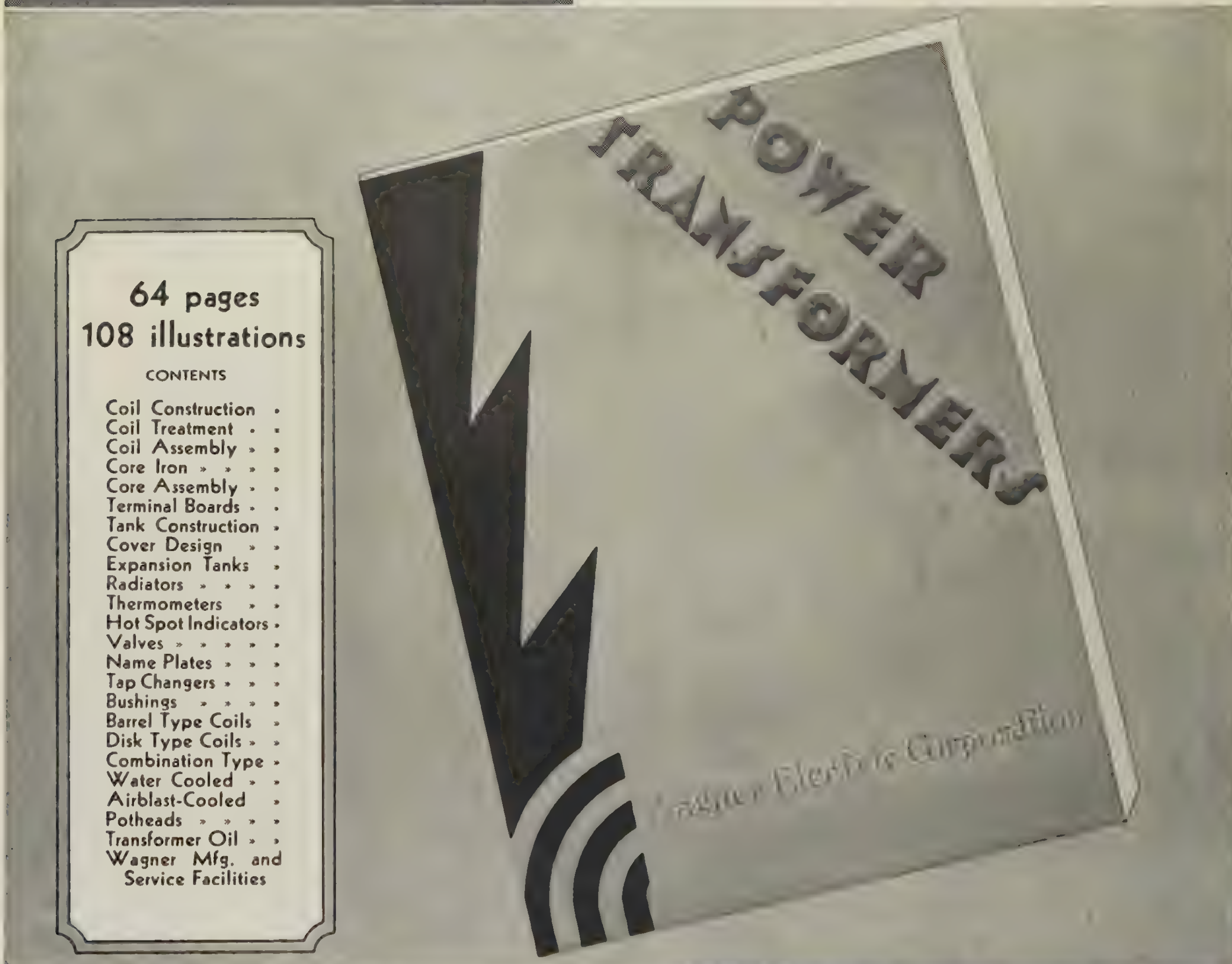

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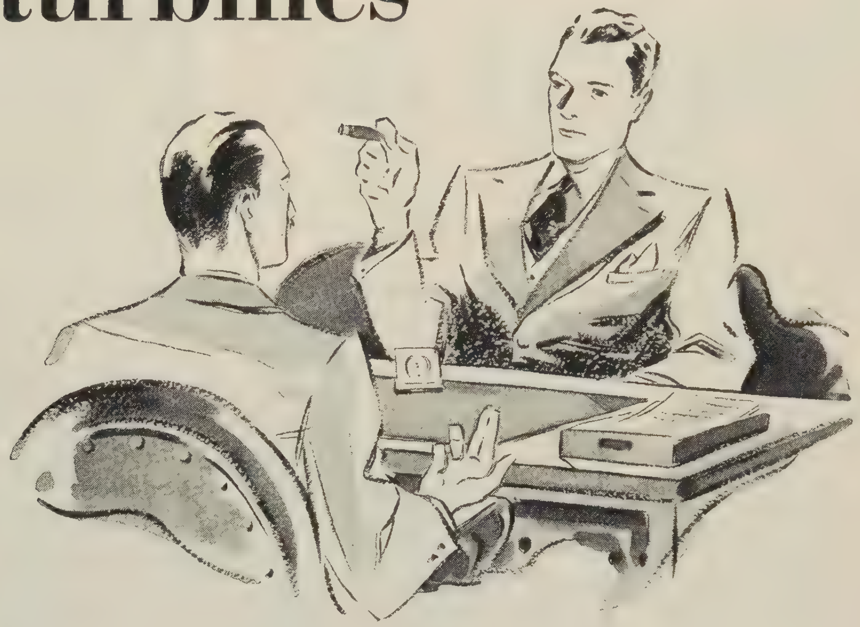

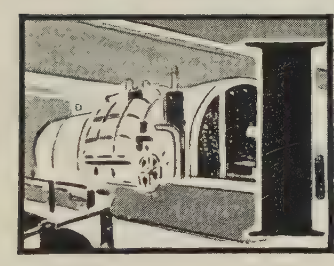

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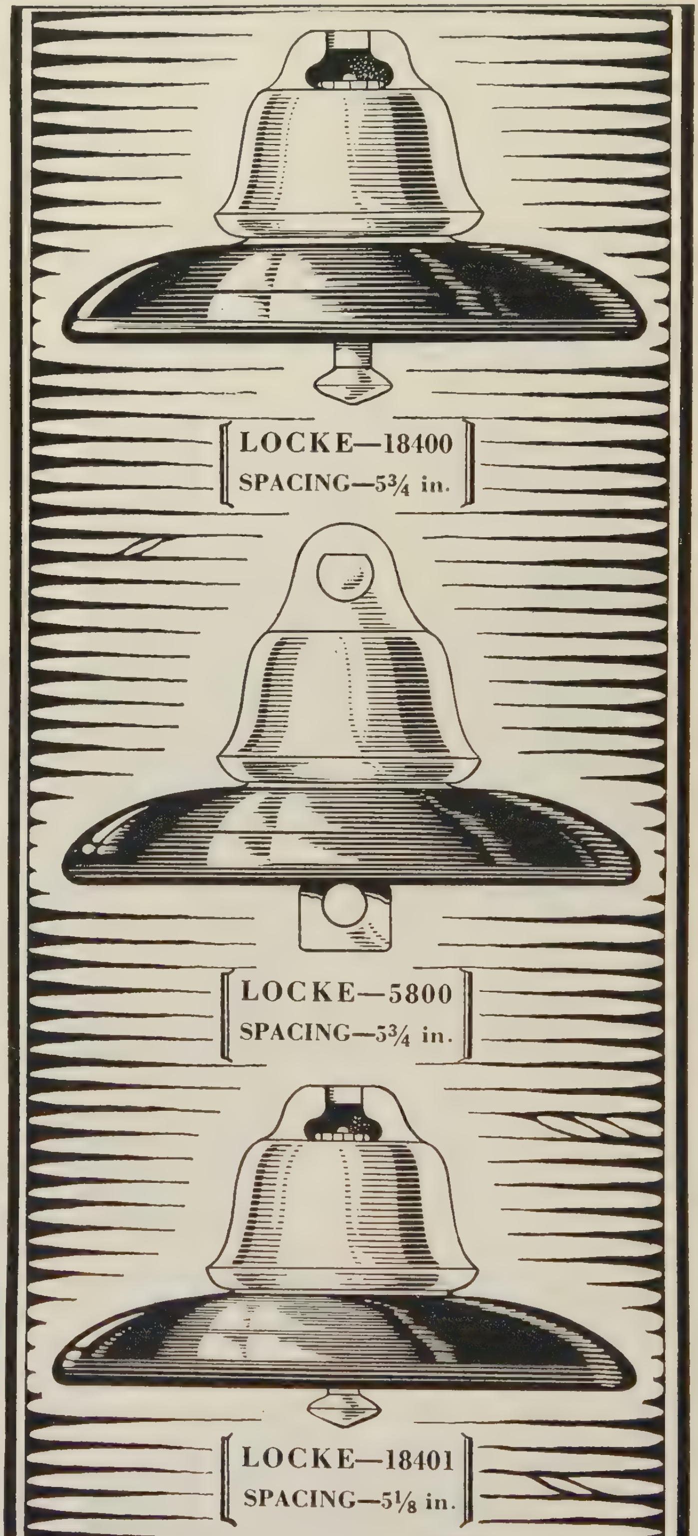

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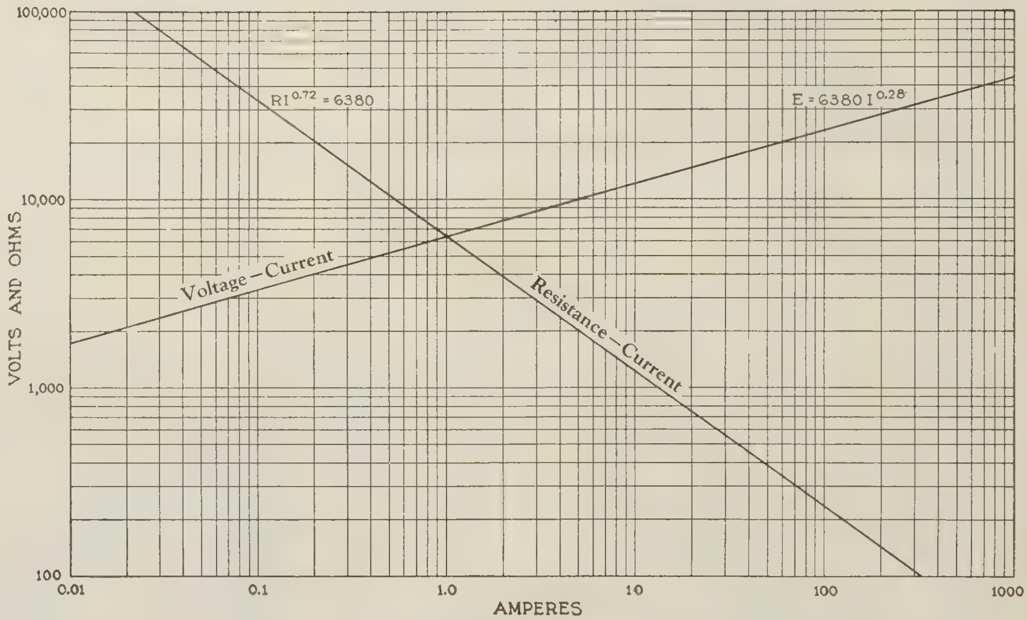
LOCKE INSULATOR CORPORATION · · · · BALTIMORE, MARYLAND

THYRITE—

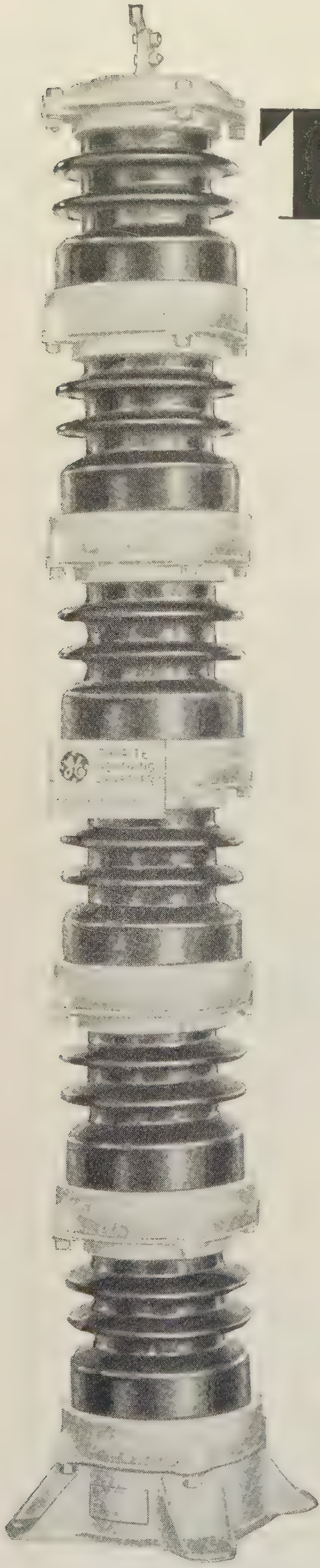


Basic Electrical Characteristics of Thyrite Material

THE qualities of Thyrite, discussed herein, are such that it has been embodied as the active material in the new G-E station-type Thyrite lightning arrester. In this application, Thyrite has placed the protective problem on an entirely new basis, enabling the accurate prediction of arrester performance for any operating condition and making possible very substantial economies.

This is the first of a series of announcements setting forth the distinctive features of Thyrite and Thyrite lightning arresters.

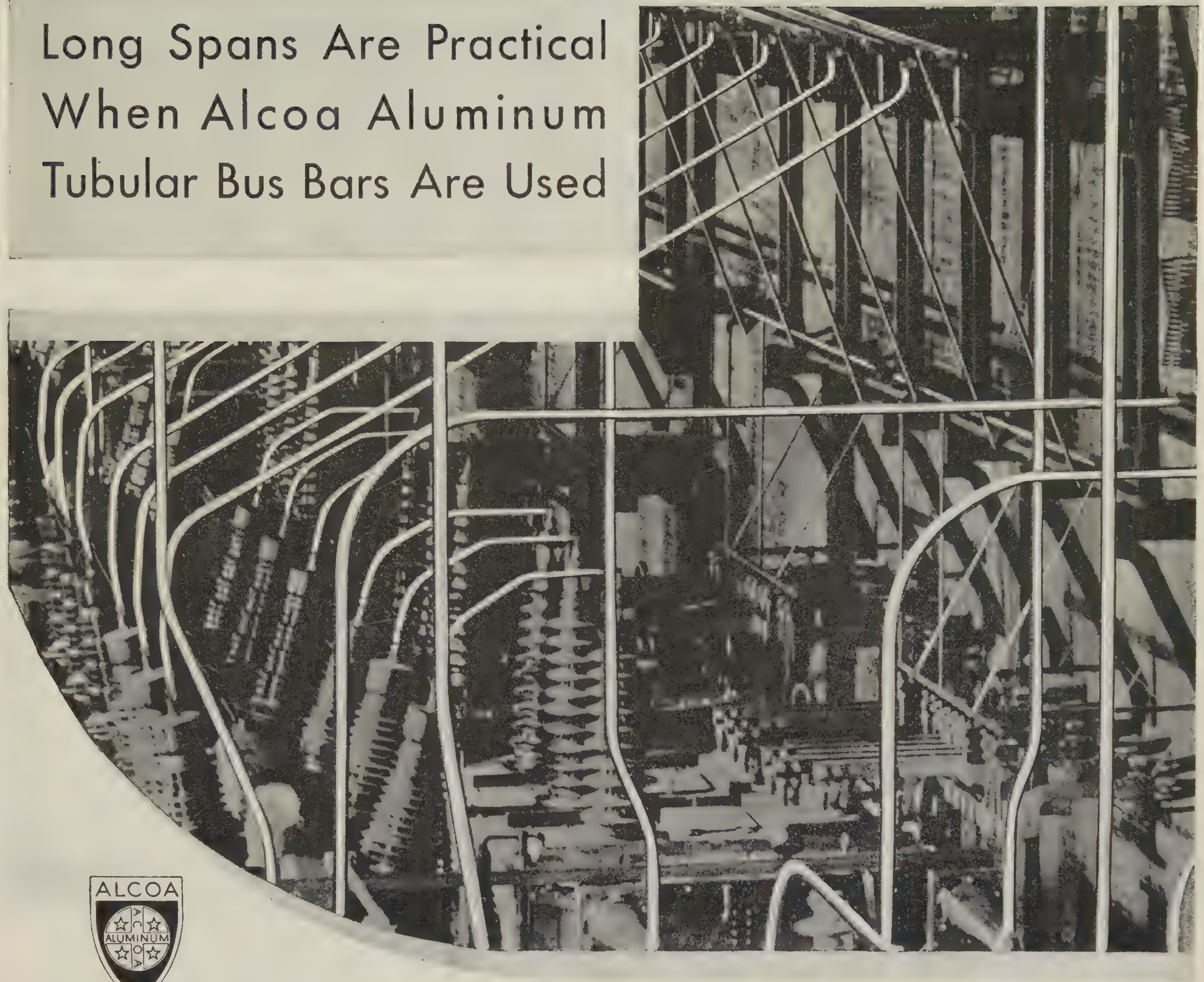
Join us in the General Electric program, broadcast every Saturday evening on a nation-wide N.B.C. network



Single-pole Thyrite arrester for 69-kv. system. Described in Bulletin GEA-1304

GENERAL

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.



The Up-Keep Cost is Low

The experience of this plant—

Typical of Many Users of EC&M Control

Hundreds of EC&M Oil-immersed Automatic Motor Starters have been in service for 10 years with little or no attention whatever.

The reason for this is simplicity of design, accurate machine work, rugged construction and oil-immersion.

One plant, for example, has over 25 EC&M Automatic Low Voltage Compensators (illustrated above to the left) that have been in service for an average of 10 years. One of these starters is used on an automatically operated pump which starts and stops every five minutes, 24 hours a day, seven days a week.

Every 18 months, the contacts on this starter are changed and the oil is changed every 3 years. No other attention has ever been required on any of these compensators.

Over 1000 industrial plants are users of EC&M Oil-immersed Automatic Control. Actual operating experience, similar to the above, has proven to them that the slightly higher cost of this equipment repays them many times over in freedom from trouble, reduced maintenance, increased production and safety.

Bulletins 1042-G, 1047-A, 1048-J and 1062 describe the construction that makes up-keep costs low with this equipment. Write for your copies.

THE ELECTRIC CONTROLLER & MFG. CO.

CLEVELAND, OHIO

NEW YORK-50 CHURCH ST.
CHICAGO-CONWAY BLDG.
DETROIT-DIME BANK BLDG.
BIRMINGHAM-BROWN-MARX BLDG.
CINCINNATI-1ST NATIONAL BANK BLDG.
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SAN FRANCISCO-CALL BUILDING
MONTREAL-CASTLE BLDG.
TULSA-COMMERCIAL BLDG.
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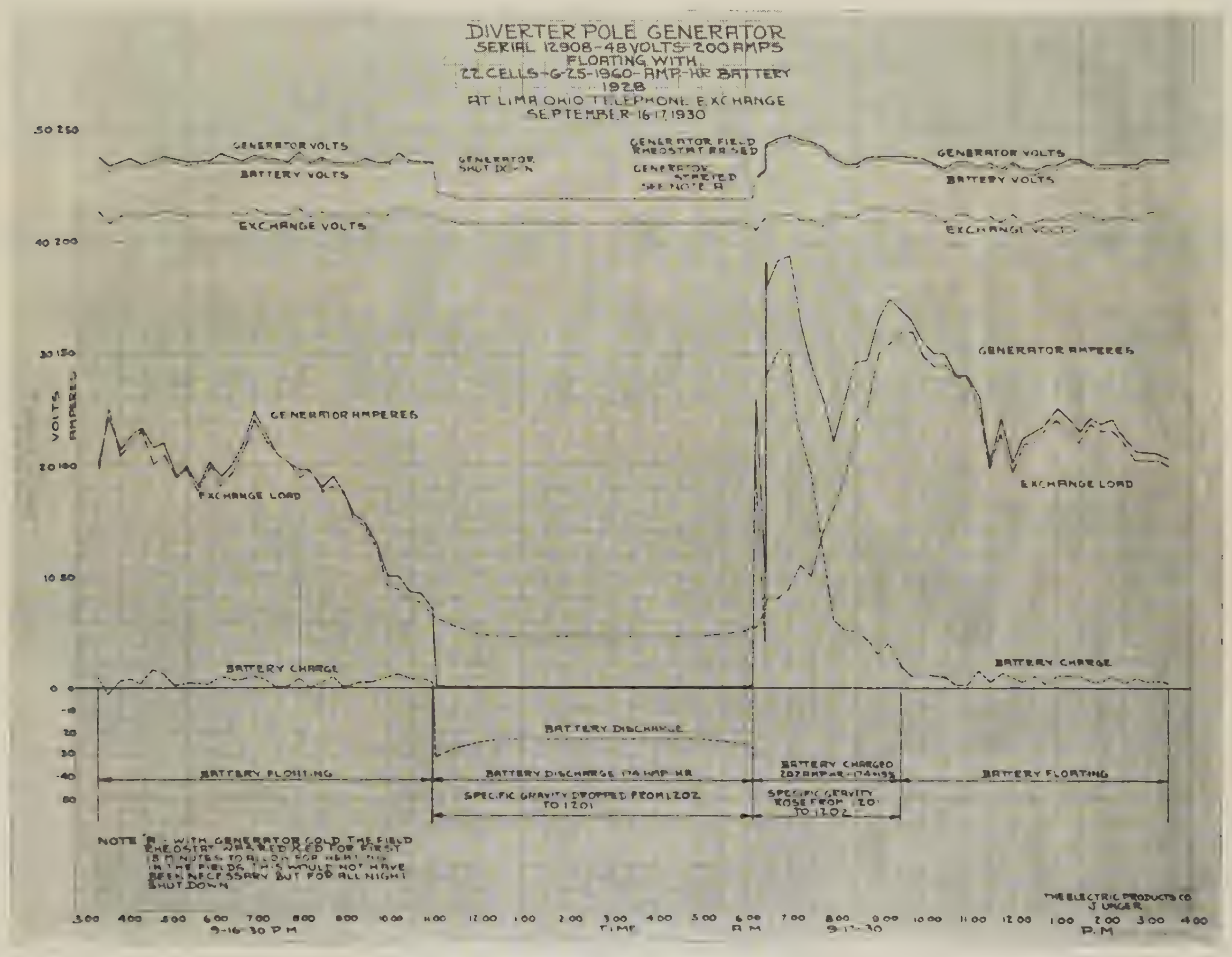
SHUNT WOUND — BATTERY CHARGER

THE DIVERTER POLE GENERATOR

CONSTANT VOLTAGE INHERENT — RUNS AS MOTOR SAFELY

THE ELECTRIC PRODUCTS COMPANY — PATENTED JAN 1926 — CLEVELAND, OHIO U.S.A.

For All Kinds of Battery Charging—With Safety & Economy



A graphic picture of Diverter Pole performance.
Long battery life a natural consequence.

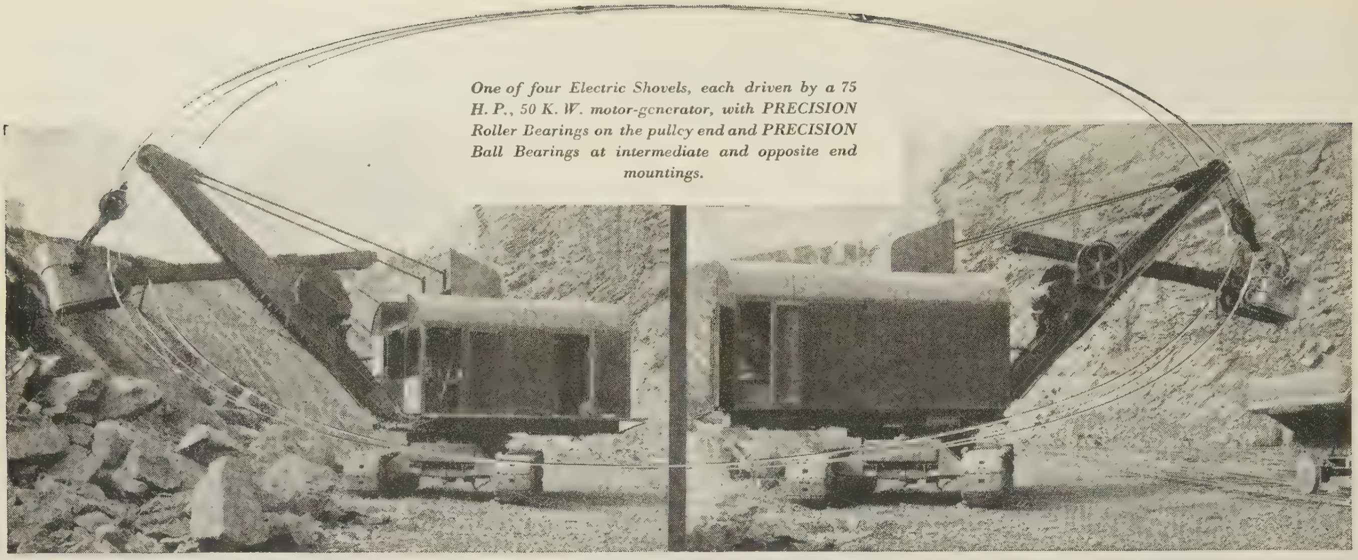
Also manufacturers of Low Voltage Electroplating Generators, variable speed D. C. Motors and Motor-Generators of all kinds.

The Electric Products Co.

CLEVELAND, OHIO

1725 Clarkstone Road

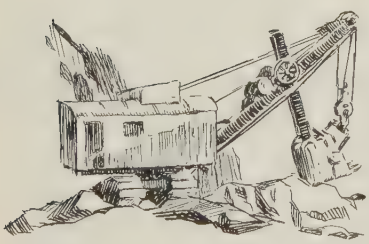
New York Office — 126 Liberty St.



One of four Electric Shovels, each driven by a 75 H. P., 50 K. W. motor-generator, with PRECISION Roller Bearings on the pulley end and PRECISION Ball Bearings at intermediate and opposite end mountings.

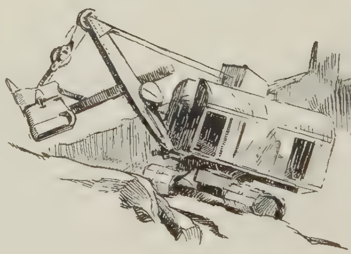
HOW A SIMPLE CHANGE-OVER TO "PRECISION" BEARINGS

PREVENTED OIL SOAKED MOTOR WINDINGS

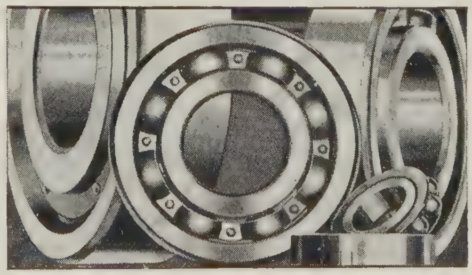


THE PROBLEM: The Nazareth Cement Co. (Nazareth, Pa.) operates four electric shovels in their quarries. The motor-generator on each unit was originally equipped with ring-oiled sleeve bearings—and considerable difficulty was experienced from the oil leaking out of the bearing housings and injuring the windings, when the shovels were swung about rapidly or tilted at an angle on uneven ground.

THE SOLUTION: The problem was taken up by our engineers and, as a result, the motor-generator units were changed over to "NORMA-HOFFMANN" Precision Ball and Roller Bearings with enclosed mountings and magazine lubrication. No further trouble was experienced.



PRECISION BEARINGS—Ball or Roller—operate safely at any angle, the method of mounting providing for the complete retention of lubricant. The change-over from sleeve bearings to PRECISION Bearings is



usually simple and inexpensive.

Other advantages gained by such a change-over are lower friction losses, less frequent oiling, longer life, easier starting. Let our engineers work with yours. Send for the Catalogs.

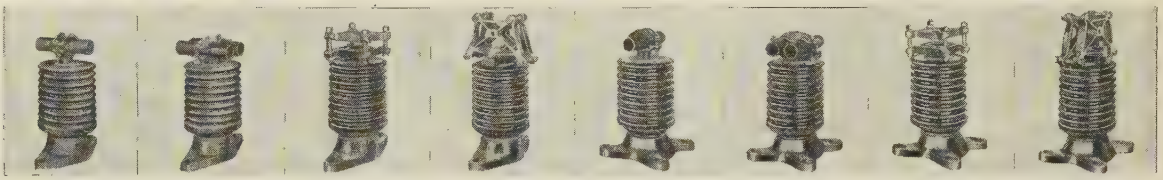
"NORMA-HOFFMANN"

PRECISION BEARINGS

BALL, ROLLER AND THRUST

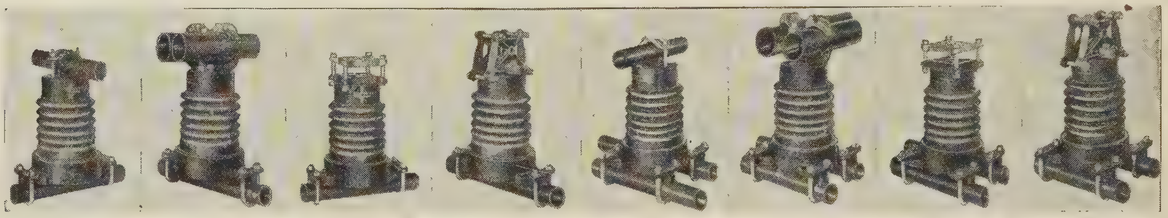
NORMA-HOFFMANN BEARINGS CORPORATION STAMFORD CONN., U.S.A.

R&IE INDOOR BUS SUPPORTS

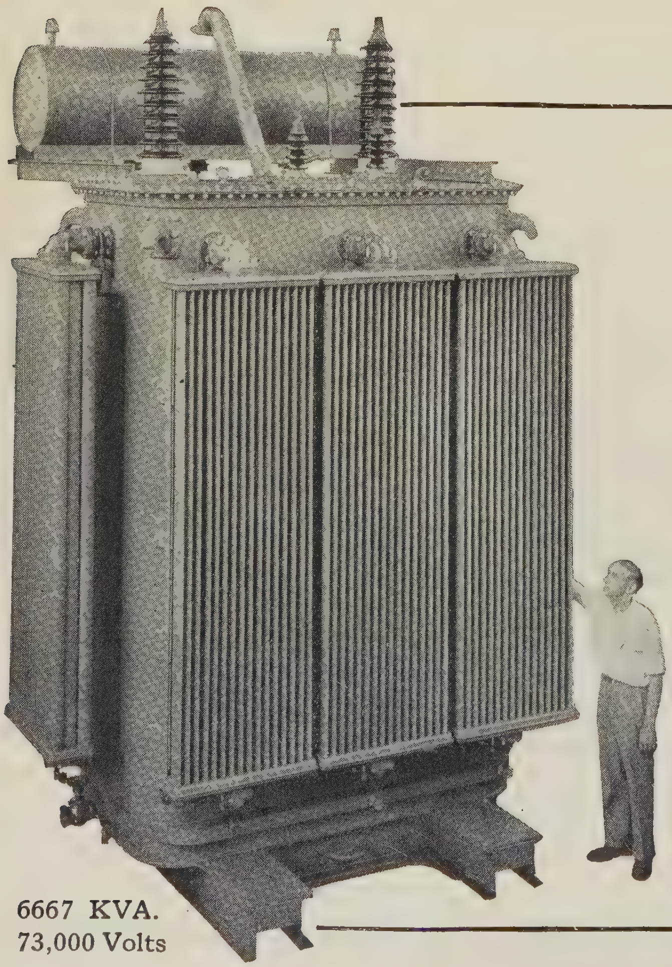


"for years to come"

Sturdy in construction, neat in appearance and high in safety factor. There is a R. & I. E. Bus Support arrangement for your every requirement. Added protection may mean added investment, but R.I.&E. cost is always consistent with R.I.&E. quality.



RAILWAY AND INDUSTRIAL ENGINEERING CO.
GREENSBURG, PA. - - - - - - - - - - *sales offices in all principal cities*



6667 KVA.
73,000 Volts

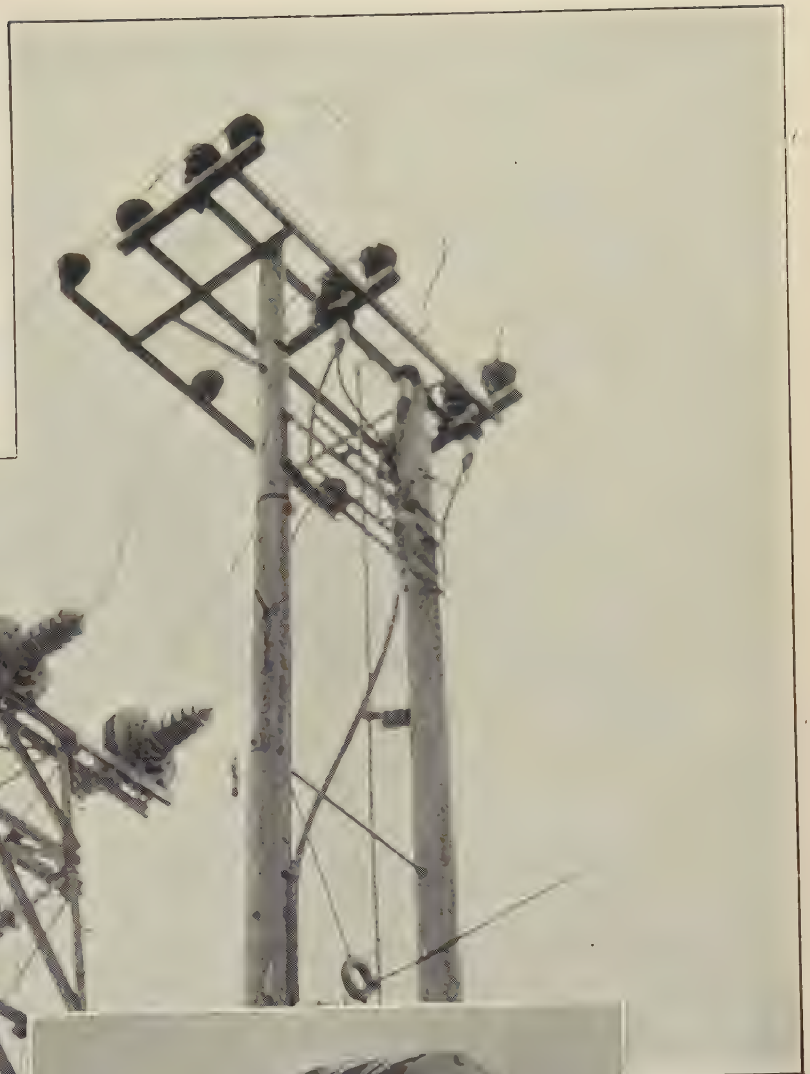
DEPENDABLE

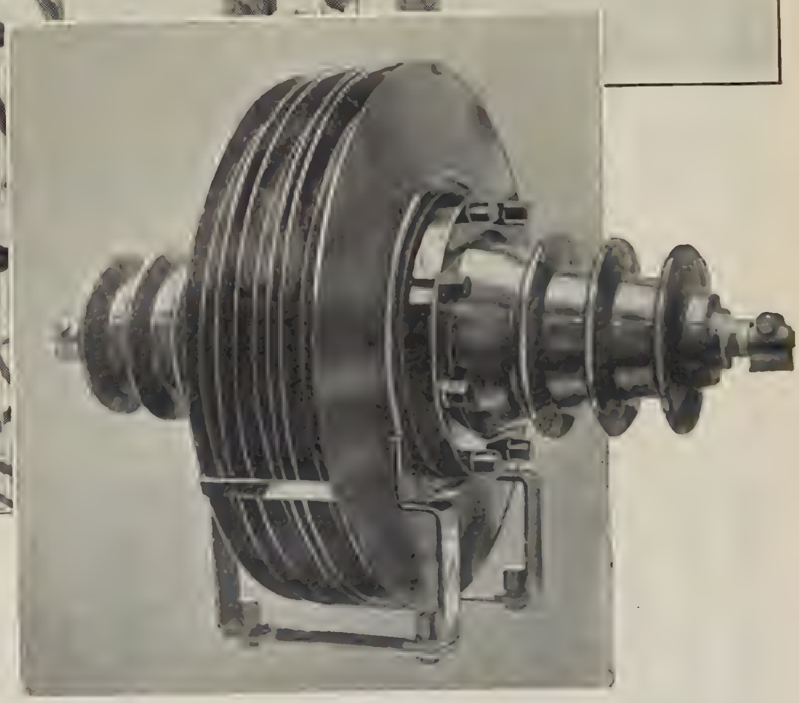
THE design, construction and materials used means that you can depend on a Moloney Transformer for any installation,—generation, transmission, distribution.

MOLONEY ELECTRIC COMPANY
St. Louis, Mo.

MOLONEY TRANSFORMERS

FERRANTI SURGE ABSORBERS



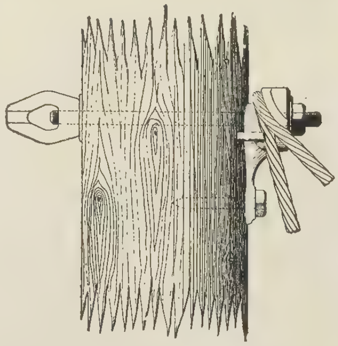


Typical installation of FERRANTI Surge Absorbers

FERRANTI ELECTRIC Limited 26 Noble Street Toronto	**FERRANTI** Incorporated 130 West 42d Street New York	**FERRANTI** Limited Hollinwood England

New Data on Guying

New Sales Bulletin No. 5, now available, suggests improved specifications for stub and anchor guying, etc., based on the proven performance of our patented P132 Guy Hook, the original design illustrated. This Guy Hook is for use with ¾″ and 1″ through-bolts, and for guy strand up to 5/8″, incl.



P129 Eye Nut—P132 Guy Hook

The P133 Guy Hook is similar but smaller throughout, and develops the full strength of 5/8″ through-bolt with strands up to 7/16″, incl., using supporting lag as illustrated. These Guy Hooks have been widely standardized as the preferred method of through-bolt guying. Bulletin No. 5 also features use of accessory Eye Nuts, Double Guying Blocks, Heavy Duty Guy Clamps, Shull Boltless Guy Clamps, Pick-up Head Anchor Rods, Curved Ribbed Washers, also standard Guy Strain Plates, J-Hooks, etc.

Send for Sales Bulletin No. 5.

Trial orders may be placed at these prices, F. O. B. Branford, Conn.

P132......$31.00 per hundred. P133......$17.00 per hundred.

Other M. I. F. Pole Hardware Specialties include: Williams Pole Mounts, Crossarm Gains, Aerial Cable Suspension Clamps, Insulated Suspension Hangers, Reinforcing and Extension Clamps for tubular steel poles, etc. Send for Bulletins on items of interest.

We feature Engineering Service for special applications

MALLEABLE IRON FITTINGS COMPANY

Pole Hardware Dept. [Factory and New England Sales Office] **Branford, Connecticut**

MIF New York Sales Office: Thirty Church Street MIF

Canadian Mfg. Distributor:

LINE & CABLE ACCESSORIES, Ltd., Toronto

THE R. THOMAS & SONS CO.

New York, Boston — Lisbon, Ohio — Chicago, London

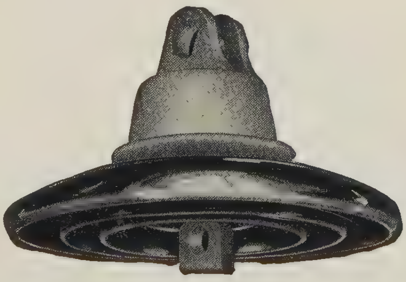
MEMCO

Insulator Clamps
Copper Fittings
Splicing Sleeves
Disconnects
Choke Coils
Fuse Mountings
Substation Combinations
Air Break Switches
Bus Supports

Memco builds this equipment in all standard and special sizes—ask for bulletins of interest to you.

Memco Engineering & Manufacturing Company, Inc.
381 Hamilton Street, Long Island City, N. Y.

INSULATORS



CANADIAN PORCELAIN CO., Ltd.
Hamilton—Ontario—Canada

Quebec District Office	*London Office*
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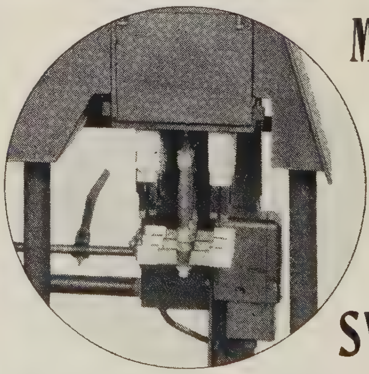
Montreal, Qu.	London, S. W. 1.



METAL-CLAD

THE MODERN

SWITCHGEAR

TYPE "CIE" 7.5 KV. 400 AMPERE OIL CIRCUIT BREAKERS

For controlling and protecting dual, across-the-line station auxiliary motors.

Electrical and mechanical interlocks, ruggedly built, yet sensitive to operation.

Liberal oil capacity, balanced air head, braced welded steel chambers, corrosion-proof parts.

No live exposed parts, separate metal compartments, decreases fire risks; shipped assembled ready for installation.

(*Ask for prices*)

Delta-Star Electric Co

2400 BLOCK, FULTON ST., CHICAGO

HEMINGRAY GLASS INSULATORS

The transparency of Hemingray Glass Insulators makes line inspection very simple. The lineman can tell at a glance whether the insulator is intact or not. Hemingray insulators are mechanically and dielectrically dependable, non-porous and uniform in structure. They defy moisture and age.

Send for Bulletin No. 1.

HEMINGRAY GLASS COMPANY
Muncie, Indiana

ROEBLING

THE LIST to the left contains merely a few of the many types of electrical wires and cables made by Roebling. From the complete, widely diversified Roebling Line practically any electrical wire or cable need can be fully met.

If you are unfamiliar with these Roebling Products, we would welcome an opportunity to supply complete information—and to demonstrate to you how exceptionally well-made and dependable they are.

Any Roebling office below would be glad to serve you. Stocks of many types of Roebling Wires and Cables are located in the cities listed.

Power Cables · Paper; Cambric; Rubber » Submarine Cables » Tree Wire » Parkway Cable » Service Cables » Station Cables » Rubber Covered Control Cables » Rubber Covered Wires and Cables · Braided and Leaded · Code: Intermediate; 30% » Slow-burning Wires and Cables » Weatherproof Wires and Cables » Portable Cords » And a wide variety of other wires and cables.

JOHN A. ROEBLING'S SONS COMPANY, TRENTON, N. J.

Atlanta Boston Chicago Cleveland Los Angeles
New York Philadelphia Portland, Ore. San Francisco Seattle

ELECTRICAL WIRES AND CABLES

A Cable that Can't Burn!

NOT a "slow-burning" (so-called) type nor yet a cable with inflammable insulation covered with a "flameproof" braid—but a cable with insulation from the copper out that just can't burn. In reality, ROCKBESTOS offers not merely a line of fireproof wires and cables, but a system of insulating with a fireproof material which can be applied to wires and cables of any material and stranding, according to specifications, and even to flexible hose for carrying air and liquids.

So insulated, wires and cables are fireproof and cannot be ignited even when placed in an acetylene flame, are heatproof which means permanently flexible, are proof against the rotting effect of oil and grease, the corrosive action of acid fumes and vapors and proof against deterioration due simply to age, probably the most destructive of all.

These qualities are the result of the novel utilization of asbestos, a material already millions of years old, which cannot age because it is already *ages old in its present form.*

Alone or in combination with other better known cable insulating materials like varnished cambric, it provides a means of installing permanent wiring in products or locations where wiring will be exposed to deteriorating elements or where there is a fire hazard.

Practically, the ROCKBESTOS line consists of wires, cables and flexible cords for service voltages up to 7500 for use in conduit or open, wherever a modern viewpoint and careful design require a genuine non-deteriorating wire.

A catalog of these wires should be in every engineering file. It will interest you. Mail us the coupon or address:

ROCKBESTOS PRODUCTS CORPORATION

382 NICOLL STREET NEW HAVEN, CONN.

Please send me without obligation the catalog you offer.

Name.................................

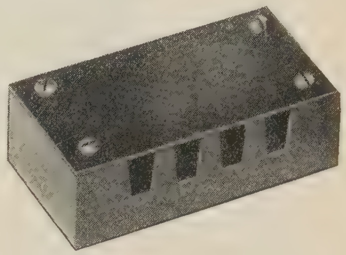
Company.................................

Address.................................

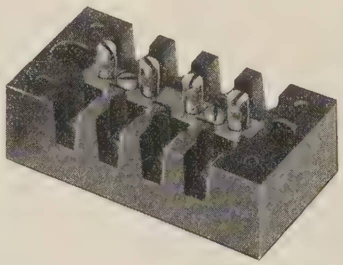
ROCKBESTOS—*The wire with permanent insulation*

BURKE CONTROLEAD TERMINAL BLOCKS

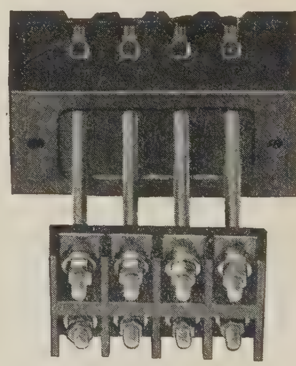
. . . . for a convenient junction point in any control wiring circuit



Burke Blocks are compact and sturdy in design, made of genuine Bakelite in three styles and five sizes, namely 2, 4, 6, 8 and 12 point.



With this selection of sizes combined with the use of the interchangeable accessory parts, Burke Blocks can be used to advantage in a wide range of installations.



Burke Terminal Blocks offer a selection adaptable to practically any control or wiring circuit.

Our engineers will be pleased to consult with you regarding special applications.

Send for BULLETIN H-2

It describes Burke Controlead Terminal Blocks in detail. You will want a copy for your file.

Alternating and Direct Current Motors and Generators, Motor Generator Sets, Arc Welding Equipment.

BURKE ELECTRIC COMPANY

main office and works: ERIE, PA.

Universal Motors, Copper Connectors, Moulded Burkelect Insulators, Controlead Terminal Blocks.

SALES AND SERVICE OFFICES IN PRINCIPAL CITIES

A special transformer

was required . . . and "AmerTran Built It"

A manufacturer needed a source of high voltage for testing insulation in large switches and circuit breakers—he required 150,000 volts at 50 kva. To satisfy this demand AMERTRAN engineers designed the oil-immersed transformer illustrated. It was fitted with a voltmeter coil to permit accurate results and a special oil-filled bushing to insure dependability. Furthermore, it was shipped in an amazingly short time.

The above is an example of one of the many types of service AMERTRAN offers you. For nearly 30 years this organization has specialized in the manufacturing transformers and testing sets of the highest quality for industrial, laboratory and radio applications. Many of the types supplied are standard, but when a stock item does not meet your requirements, we are prepared to build special equipment.

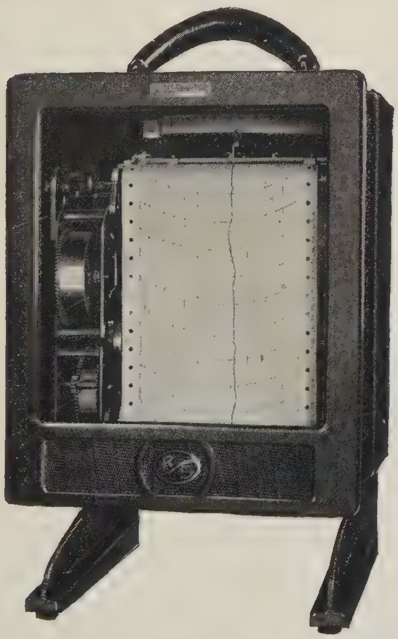
The next time you need a transformer, whether it be large or small, let us have your specifications. Our engineers welcome the opportunity of assisting you, and you will find AMERTRAN quality and service second to none.

AMERICAN TRANSFORMER COMPANY

Transformer builders for over 29 years.

180 EMMET ST. AMER TRAN **NEWARK, N. J.**

AMERTRAN TRANSFORMERS



Roller-Smith Graphics

Need no "Coddling"

The powerful clock runs evenly—without coaxing.

The mechanisms, sturdy, efficient and sensitive, are not easily damaged by abuse or overload.

The 5″ chart moves along smoothly without jerking or buckling.

The chart rolls are as easy to install as a new film in a Kodak.

The ink flows freely irrespective of temperature, humidity or how long the instrument has been idle.

The ink well is so easy to fill that a child could do it.

The case is made of light but strong aluminum which does not easily crack or break.

And when servicing **is** required everything is not only accessible but **get-at-able**—there is a **world** of difference.

ROLLER-SMITH GRAPHICS are made for direct and alternating current; switchboard, wall and portable models and as ammeters, voltmeters, single and polyphase wattmeters and power factor meters. Either clock or synchronous motor drive is available. Send for Bulletin AE-830 for further details or, better still, get in touch with the R-S office nearest you. There is one in every important City in the U. S. A. and Canada.

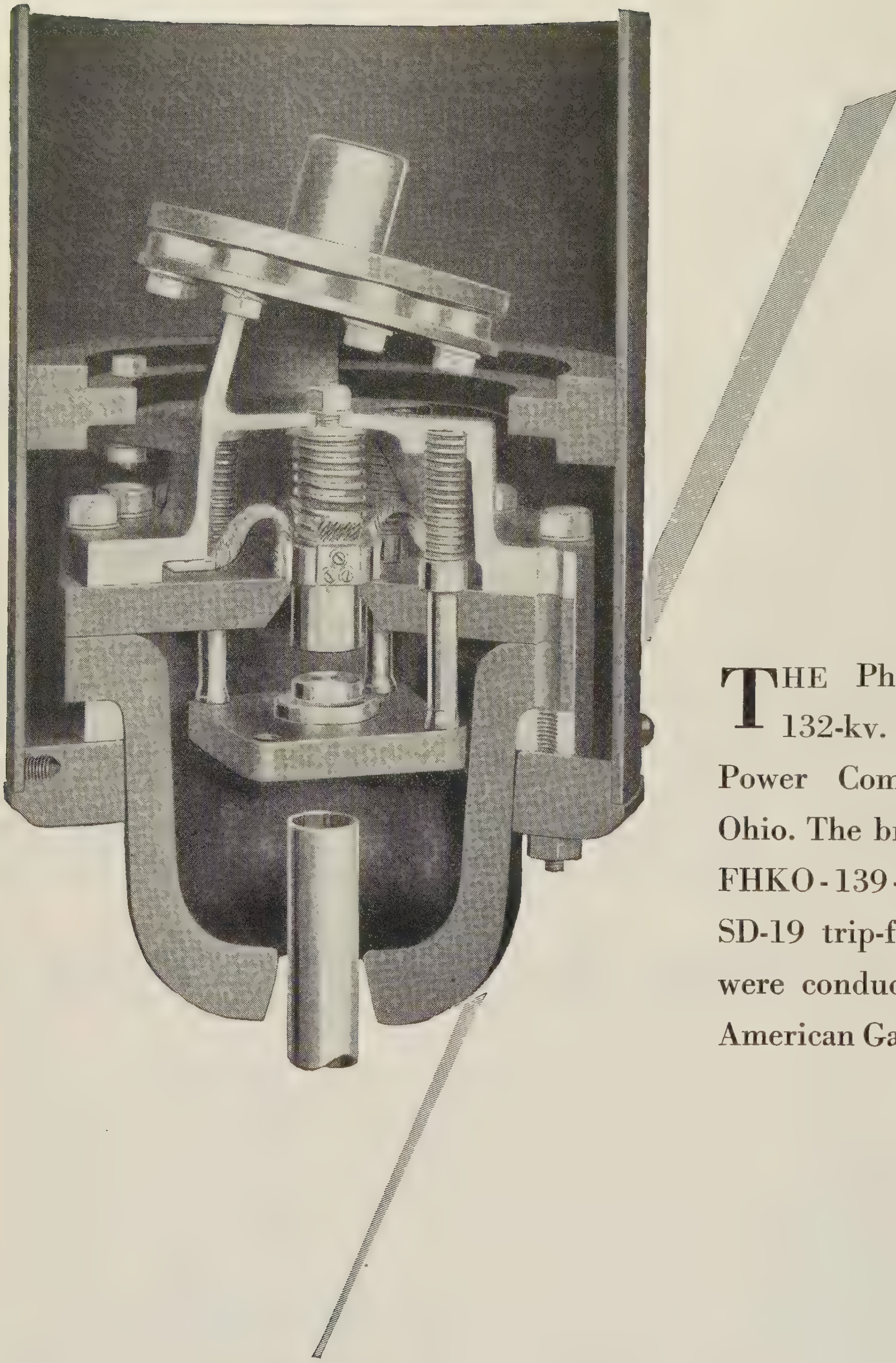
Forty years' instrument experience in back of

ROLLER-SMITH COMPANY

Electrical Measuring and Protective Apparatus

MAIN OFFICE: 12 Park Place, NEW YORK — ROLLER SMITH — **WORKS:** Bethlehem, Penna.

OIL BLAST



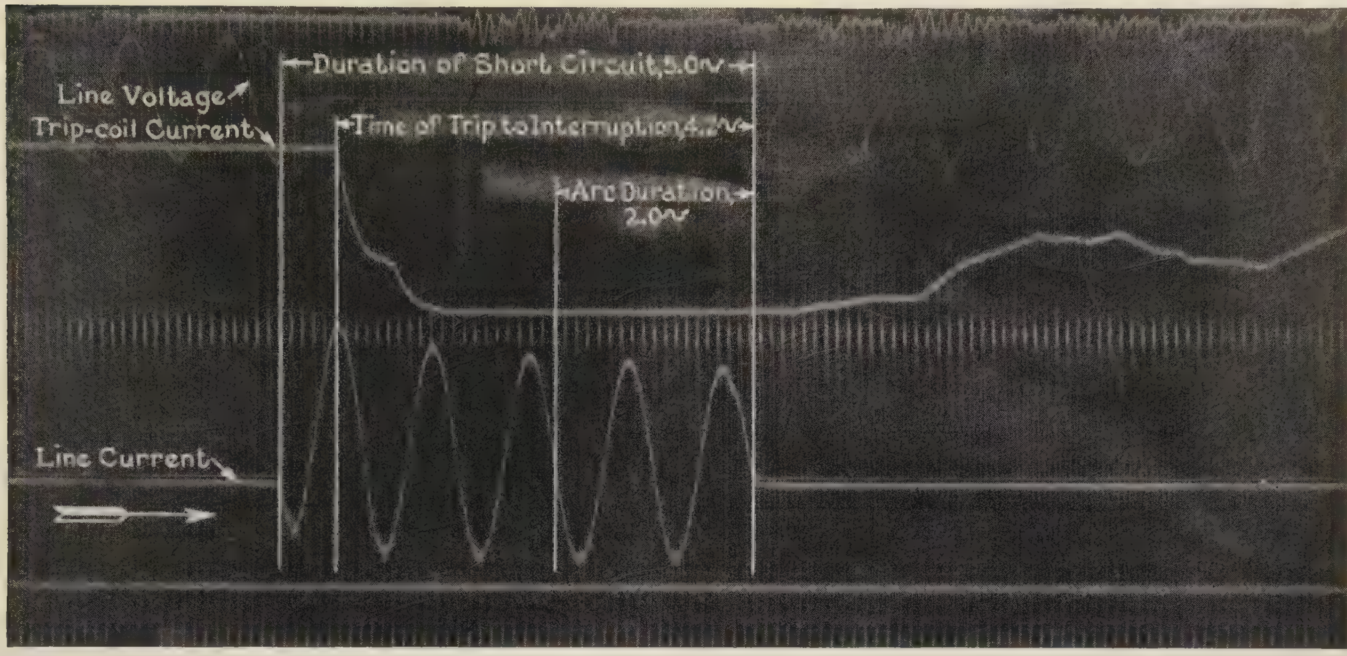
THE Philo Station is on the 132-kv. system of the Ohio Power Company near Zanesville, Ohio. The breaker tested was a Type FHKO-139-60B with a standard SD-19 trip-free solenoid. The tests were conducted by courtesy of the American Gas and Electric Company.

GENERAL ELECTRIC

SWITCHGEAR

470-22

EXPLOSION CHAMBER PROVED AT PHILO



One of the many oscillograms taken during the Philo test. It shows interruptions of 1,540,000 kv-a., which is in excess of the breaker rating. Line voltage, 140,000 volts; current, 6,350 amp.; frequency, 60 cycles

OSCILLOGRAPHIC records provide conclusive evidence that, with this important improvement, the interrupting ability of oil circuit breakers is greater than ever. The tests were made under the severest conditions of short circuit thus far created.

The average arc duration of all tests was 3.5 cycles. The average arc length was 6.8 inches. The time of breaker operation averaged 5.9 cycles. Recovery voltage was as high as 2400 volts per microsecond. Line voltage was 140 kv.

Stability is now possible on all systems because, with the new explosion chamber, there is no delay of circuit interruption. A blast of oil and the arc is out. Consider the advantages — quicker arc extinction, faster breaker operation, and consistent performance at varying currents.

Additional advantages are: complete arc confinement, small volume and effectual cooling of gases, low tank pressure, slow rate of oil deterioration, and minimum contact burning and maintenance.

JOIN US IN THE GENERAL ELECTRIC PROGRAM, BROADCAST EVERY SATURDAY EVENING ON A NATION-WIDE N.B.C. NETWORK

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Western Electric Co., All Principal Cities

AMMETER COMPENSATING COILS
Minerallac Electric Co., Chicago

AMMETER, VOLTMETERS
(See INSTRUMENTS, ELECTRICAL)

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Kearney Corp., Jas. R., St. Louis

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Electric Specialty Co., Stamford, Conn.
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Wagner Electric Corp., St. Louis
Ward Leonard Electric Co.,Mt. Vernon, N.Y.
Western Electric Co., All Principal Cities
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

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Norma-Hoffman Bearings Corp., Stamford, Conn.

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Metropolitan Device Corp., Brooklyn, N. Y.
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Westinghouse Elec. & Mfg. Co., E. Pittsburgh

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G & W Elec. Specialty Co., Chicago
Metropolitan Device Corp., Brooklyn, N. Y.

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National Carbon Co., Inc., Cleveland
Westinghouse Elec. & Mfg. Co., E. Pittsburgh
Copper Graphite
Morganite Brush Co., Inc., L. I. City, N. Y.
National Carbon Co., Inc., Cleveland
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

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General Electric Co., Schenectady
Memco Engg. & Mfg. Co., L. I. City, N. Y.
Ohio Brass Co., Mansfield, O.
Railway & Ind. Engg. Co., Greensburg, Pa.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

BUSHINGS, PORCELAIN
Ohio Brass Co., Mansfield, O.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

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Delta-Star Electric Co., Chicago
Dossert & Co., New York
G & W Electric Specialty Co., Chicago
General Electric Co., Schenectady
Minerallac Electric Co., Chicago
Western Electric Co., All Principal Cities

CABLE RACKS
Metropolitan Device Corp., Brooklyn, N. Y.

CABLES
SEE WIRES AND CABLES

CABLEWAYS
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Roebling's Sons Co., John A., Trenton, N. J.

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Roller-Smith Co., New York
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Western Electric Co., All Principal Cities
Oil
Condit Electrical Mfg. Corp., Boston
General Electric Co., Schenectady
Roller-Smith Co., New York
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

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Kearney Corp., Jas. R., St. Louis
Malleable Iron Fittings Co., Branford, Conn.
Railway Ind. & Engg. Co., Greensburg, Pa.

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Memco Engg. & Mfg. Co., L. I. City, N. Y.

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General Electric Co., Schenectady
Kearney Corp., Jas. R., St. Louis
Memco Engg. & Mfg. Co., L. I. City, N. Y.
Railway & Ind. Engg. Co., Greensburg, Pa.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

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General Radio Co., Cambridge, Mass.

CONDENSERS, STEAM
Allis-Chalmers Mfg. Co., Milwaukee
General Electric Co., Schenectady
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

CONDUIT, UNDERGROUND FIBRE
Western Electric Co., All Principal Cities

CONNECTORS SOLDERLESS
Burke Electric Co., Erie, Pa.
Dossert & Co., New York
Kearney Corp., Jas. R., St. Louis
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

CONNECTORS AND TERMINALS
Belden Mfg. Co., Chicago
Burke Electric Co., Erie, Pa.
Burndy Engineering Co., Inc., New York
Champion Switch Co., Kenova, West Va.
Dossert & Co., New York
G & W Electric Specialty Co., Chicago
Railway & Ind. Engg. Co., Greensburg, Pa.
Western Electric Co., All Principal Cities
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

CONTACTS, TUNGSTEN
General Electric Co., Schenectady

CONTROL SYSTEMS
Ward Leonard Electric Co., Mt. Vernon, N. Y.

CONTROLLERS
Electric Controller & Mfg. Co., Cleveland
General Electric Co., Schenectady
Rowan Controller Co., Baltimore, Md.
Ward Leonard Electric Co., Mt. Vernon, N. Y.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

CONVERTERS—SYNCHRONOUS
Allis-Chalmers Mfg. Co., Milwaukee
Electric Specialty Co., Stamford, Conn.
Wagner Electric Corp., St. Louis
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

COPPER CLAD WIRE
Western Electric Co., All Principal Cities

COPPERWELD WIRE
Copperweld Steel Co., Glassport, Pa.

CUT-OUTS
Bull Dog Electric Products Co., Detroit
Condit Electrical Mfg. Corp., S. Boston
General Electric Co., Schenectady
G & W Electric Specialty Co., Chicago
Kearney Corp., Jas. R., St. Louis
Metropolitan Device Corp., Brooklyn, N. Y.
Wagner Electric Corp., St. Louis
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

DIMMERS, THEATRE
Ward Leonard Electric Co., Mt. Vernon, N. Y.

DIVERTER POLE GENERATORS
Electric Products Co., Cleveland, O.

DYNAMOS
(See GENERATORS AND MOTORS)

DYNAMOTORS
Burke Electric Co., Erie, Pa.
Electric Products Co., Cleveland, O.
Electric Specialty Co., Stamford, Conn.

ELECTRIFICATION SUPPLIES, STEAM ROAD
General Electric Co., Schenectady
Ohio Brass Co., Mansfield, Ohio
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

ENGINEERS, CONSULTING AND CONTRACTING
(See PROFESSIONAL ENGINEERING DIRECTORY)

ENGINES
Gas & Gasoline
Allis-Chalmers Mfg. Co., Milwaukee
Oil
Allis-Chalmers Mfg. Co., Milwaukee
Steam
Allis-Chalmers Mfg. Co., Milwaukee

EXPERIMENTAL WORK
Manufacturers' and Inventors' Electric Co., New York

FANS, MOTOR
General Electric Co., Schenectady
Wagner Electric Corp., St. Louis
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

FLOW METERS
General Electric Co., Schenectady

FURNACES, ELECTRIC
General Electric Co., Schenectady
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

FUSES
Enclosed Refillable
General Electric Co., Schenectady
Westinghouse Elec. & Mfg. Co., E. Pittsburgh
Enclosed Non-Refillable
General Electric Co., Schenectady
Open Link
General Electric Co., Schenectady
Metropolitan Device Corp., Brooklyn, N. Y.
High-Tension
Metropolitan Device Corp., Brooklyn, N. Y.
Railway & Ind. Engg. Co., Greensburg, Pa.

FUSE MOUNTINGS
Memco Engg. & Mfg. Co., L. I. City, N. Y.
Railway & Ind. Engg. Co., Greensburg, Pa.

FUSE PULLERS
Kearney Corp., Jas. R., St. Louis

GEARS, FIBRE
General Electric Co., Schenectady

GENERATORS AND MOTORS
Allis-Chalmers Mfg. Co., Milwaukee
Burke Electric Co., Erie, Pa.
Chandeysson Electric Co., St. Louis
Electric Products Co., Cleveland, O.
Electric Specialty Co., Stamford, Conn.
Electro-Dynamic Co., Bayonne, N. J.
General Electric Co., Schenectady
Wagner Electric Corp., St. Louis
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

Index to Advertised Products—*Continued*

GENERATING STATION EQUIPMENT
Allis-Chalmers Mfg. Co., Milwaukee
Burke Electric Co., Erie, Pa.
General Electric Co., Schenectady
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

GROUND RODS
Copperweld Steel Co., Glassport, Pa.
Metropolitan Device Corp., Brooklyn, N. Y.

HARDWARE, POLE LINE AND INSULATOR
General Electric Co., Bridgeport, Conn.
Ohio Brass Co., Mansfield, O.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

HEADLIGHTS
Ohio Brass Co., Mansfield, O.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

HEATERS, INDUSTRIAL
General Electric Co., Schenectady
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

INDICATORS, SPEED
Roller-Smith Co., New York
Weston Elec. Inst. Corp., Newark, N. J.

NSTRUMENTS, ELECTRICAL

Graphic
Cambridge Instrument Co., New York
Ferranti, Ltd., Hollinwood, England
Ferranti, Inc., New York
Ferranti Electric, Ltd., Toronto, Ont.
General Electric Co., Schenectady
Roller-Smith Co., New York
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

Indicating
Cambridge Instrument Co., New York
Ferranti, Ltd., Hollinwood, England
Ferranti, Inc., New York
Ferranti Electric, Ltd., Toronto, Ont.
General Electric Co., Schenectady
Jewell Elec. Instrument Co., Chicago
Roller-Smith Co., New York
Sangamo Electric Company, Springfield, Ill.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh
Weston Elec. Inst. Corp., Newark, N. J.

Integrating
Ferranti, Ltd., Hollinwood, England
Ferranti, Inc., New York
Ferranti Electric, Ltd., Toronto, Ont.
General Electric Co., Schenectady
Sangamo Electric Company, Springfield, Ill.
Western Electric Co., All Principal Cities
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

Radio
Cambridge Instrument Co., New York
General Radio Co., Cambridge, Mass.
Jewell Elec. Instrument Co., Chicago
Roller-Smith Co., New York
Weston Elec. Inst. Corp., Newark, N. J.

Repairing and Testing
Cambridge Instrument Co., New York
Electrical Testing Laboratories, New York
Jewell Elec. Instrument Co., Chicago
Roller-Smith Co., New York
Weston Elec. Inst. Corp., Newark, N. J.

Scientific, Laboratory, Testing
Cambridge Instrument Co., New York
General Electric Co., Schenectady
Jewell Elec. Instrument Co., Chicago
Metropolitan Device Corp., Brooklyn, N. Y.
Roller-Smith Co., New York
Western Electric Co., All Principal Cities
Westinghouse Elec. & Mfg. Co., E. Pittsburgh
Weston Elec. Inst. Corp., Newark, N. J.

INSULATING MATERIALS

Board
General Electric Co., Bridgeport, Conn.
West Va. Pulp & Paper Co., New York

Cloth
General Electric Co., Bridgeport, Conn.
Mica Insulator Co., New York
Minerallac Electric Co., Chicago
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

Composition
American Lava Corp., Chattanooga
General Electric Co., Bridgeport, Conn.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

Compounds
General Electric Co., Bridgeport, Conn.
Mica Insulator Co., New York
Minerallac Electric Co., Chicago
Western Electric Co., All Principal Cities
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

Fibre
General Electric Co., Bridgeport, Conn.
West Va. Pulp & Paper Co., New York

Lava
American Lava Corp., Chattanooga, Tenn.

INSULATING MATERIALS—*Continued*

Mica
Mica Insulator Co., New York
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

Paper
General Electric Co., Bridgeport, Conn.
Mica Insulator Co., New York
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

Silk
General Electric Co., Bridgeport, Conn.

Tape
General Electric Co., Bridgeport, Conn.
Mica Insulator Co., New York
Minerallac Electric Co., Chicago
Okonite Co., The, Passaic, N. J.
Western Electric Co., All Principal Cities
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

Varnishes
General Electric Co., Bridgeport, Conn.
Mica Insulator Co., New York
Minerallac Electric Co., Chicago
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

INSULATORS, HIGH TENSION

Composition
Burke Electric Co., Erie, Pa.
General Electric Co., Schenectady

Glass
Hemingray Glass Co., Muncie, Ind.

Porcelain
Canadian Porcelain Co., Ltd., Hamilton, Ont.
Champion Switch Co., Kenova, West Va.
General Electric Co., Schenectady
Lapp Insulator Co., Inc., LeRoy, N. Y.
Locke Insulator Corp., Baltimore
Ohio Brass Co., Mansfield, O.
Thomas & Sons Co., R., Lisbon, O.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

Post Type
Delta-Star Electric Co., Chicago
Ohio Brass Co., Mansfield, O.
Railway & Ind. Engg. Co., Greensburg, Pa.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

INSULATORS, TELEPHONE & TELEGRAPH
Hemingray Glass Co., Muncie, Ind.
Ohio Brass Co., Mansfield, O.

INSULATOR PINS
Ohio Brass Co., Mansfield, O.
Thomas & Sons, Co., R., Lisbon, O.

LADDERS, TRUCK
Metropolitan Device Corp., Brooklyn, N. Y.

LAVA
American Lava Corp., Chattanooga

LIGHTNING ARRESTERS
Delta-Star Electric Co., Chicago
General Electric Co., Schenectady
Western Electric Co., All Principal Cities
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

LOCOMOTIVES, ELECTRIC
General Electric Co., Schenectady
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

LUBRICANTS
Texas Company, The, New York

MAGNETIC SEPARATORS
Electric Controller & Mfg. Co., Cleveland

METERS, ELECTRICAL
(See INSTRUMENTS ELECTRICAL)

METER SEALS
Metropolitan Device Corp., Brooklyn, N. Y.

MICA PRODUCTS
Mica Insulator Co., New York
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

MOLDED INSULATION
Burke Electric Co., Erie, Pa.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

MOTORS
(See GENERATORS AND MOTORS)

OHMMETERS
Jewell Elec. Instrument Co., Chicago
Roller-Smith Co., New York
Weston Elec. Inst. Corp., Newark, N. J.

OIL SEPARATORS & PURIFIERS
Sharples Specialty Co., The, Philadelphia
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

OIL TESTING SETS
American Transformer Co., Newark, N. J.

PANEL BOARDS
(See SWITCHBOARDS)

PATENT ATTORNEYS
(See PROFESSIONAL ENGINEERING DIRECTORY)

PLATING GENERATORS
Burke Electric Co., Erie, Pa.
Chandeysson Electric Co., St. Louis
Electric Products Co., Cleveland, O.
Electric Specialty Co., Stamford, Conn.

PLUGS
Delta-Star Electric Co., Chicago
General Electric Co., Schenectady
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

POLE MOUNTS
Malleable Iron Fittings Co., Branford, Conn.

POLE LINE HARDWARE
General Electric Co., Bridgeport, Conn.
Ohio Brass Co., Mansfield, O.

POTHEADS
G & W Electric Specialty Co., Chicago
Ohio Brass Co., Mansfield, O.
Railway & Ind. Engg. Co., Greensburg, Pa.

PUBLIC ADDRESS SYSTEMS
Western Electric Co., All Principal Cities

PUMPS
Allis-Chalmers Mfg. Co., Milwaukee

RADIO LABORATORY APPARATUS
General Radio Co., Cambridge, Mass.
Western Electric Co., All Principal Cities
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

RAILWAY SUPPLIES, ELECTRIC
General Electric Co., Schenectady
Ohio Brass Co., Mansfield, O.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

REACTORS
General Electric Co., Schenectady
Metropolitan Device Corp., Brooklyn, N. Y.

RECTIFIERS
General Electric Co., Schenectady
Wagner Electric Corp., St. Louis
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

REGULATORS, VOLTAGE
General Electric Co., Schenectady
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

RELAYS
Condit Elec. Mfg. Corp., Boston
Electric Controller & Mfg. Co., Cleveland
General Electric Co., Schenectady
Roller-Smith Co., New York
Ward Leonard Electric Co., Mt. Vernon, N.Y.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh
Weston Elec. Inst. Corp., Newark, N. J.

RESISTORS, VITREOUS
Electrad, Inc., New York
Ward Leonard Electric Co., Mt. Vernon, N. Y.

RESISTOR UNITS
Electrad, Inc., New York
General Electric Co., Schenectady
Ward Leonard Electric Co., Mt. Vernon, N.Y.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

RHEOSTATS
General Electric Co., Schenectady
Ward Leonard Electric Co., Mt. Vernon, N.Y.
Western Electric Co., All Principal Cities
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

ROPE, WIRE
American Steel & Wire Co., Chicago
Roebling's Sons Co., John A., Trenton, N. J.

SEARCHLIGHTS
General Electric Co., Schenectady
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

SLEEVE TWISTERS
Kearney Corp., Jas. R., St. Louis

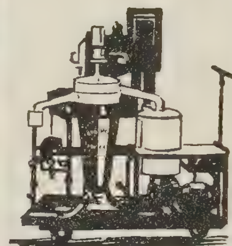
SLEEVES, SPLICING
Memco Engg. & Mfg. Co., L. I. City, N. Y.

SOCKETS AND RECEPTACLES
General Electric Co., Schenectady
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

SOLENOIDS
Electric Controller & Mfg. Co., Cleveland
General Electric Co., Schenectady
Roebling's Sons Co., John A., Trenton, N. J.
Roller-Smith Co., New York
Ward Leonard Electric Co., Mt. Vernon, N. Y.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

SOUND DISTRIBUTION SYSTEMS
American Transformer Co., Newark, N. J.

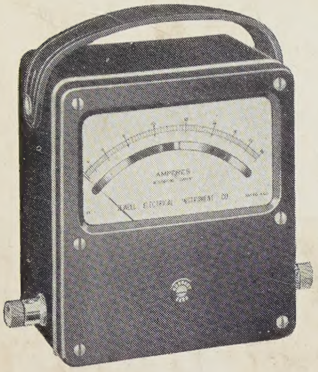
SPRINGS
American Steel & Wire Co., Chicago



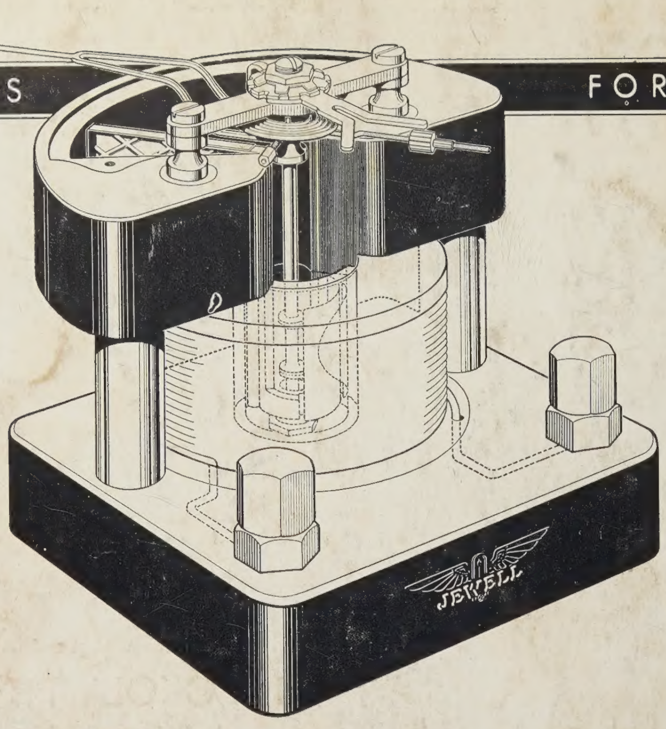
Index to Advertised Products—*Continued*

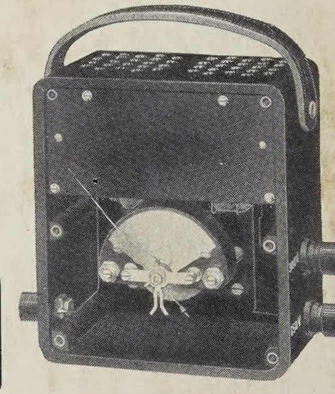
ALPHABETICAL LIST OF ADVERTISERS

INSTRUMENTS FOR INDUSTRY



The remarkably large scale opening enclosed with non-shatterable glass makes it easy to read Jewell Master Instruments.





Jewell A. C. Movements are mounted in dust-tight cases with separate ventilated compartments for voltmeter resistances.

The STYLE D MOVEMENT

in Master A. C. Instruments

employs an old principle in the modern manner

JEWELL

MASTER INSTRUMENTS

- Pattern 170— Current Transformer
- Pattern 171— D. C. Voltmeter or Ammeter
- Pattern 172— A. C. Voltmeter or Ammeter
- Pattern 173— Single Phase Wattmeter
- Pattern 174— VoltAmpWattmeter
- Pattern 175— Polyphase Wattmeter
- Pattern 176— Thermal Voltmeter

The repulsion of similar magnetic poles was discovered long ago. The Jewell Style D Iron Vane Movement employs this ancient principle in the modern manner. For true simplicity, no electrical measuring instrument can compare with the iron vane movement used in Jewell Master A. C. Voltmeters and Ammeters.

The insistent demand for a reliable portable A. C. instrument to withstand the severe treatment of industrial testing has been met with the Jewell Line of Master A. C. Instruments. The Style D Movement incorporates a long series of important refinements. The special design of the iron vanes produces a scale most open in the working range.

The bakelite mountings, the rustproofing of parts and the amazingly close tolerances to which these instrument parts are made, easily explain why rigidity, light weight, accuracy, and reliability are intrinsic qualities of Jewell Master Portable A. C. Instruments.

Send for the Jewell Master Portable Instrument Catalog today

Jewell Electrical Instrument Co., 1650 Walnut Street, Chicago, Ill.

30 YEARS MAKING GOOD INSTRUMENTS

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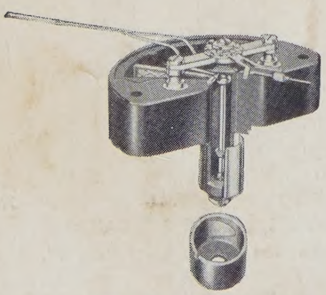
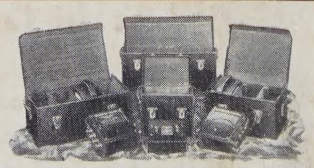


The moving element combines ruggedness with extreme sensitivity.



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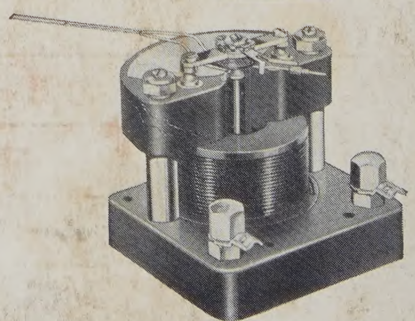
The uniform dimensions of Master Portable Instruments make for utmost convenience. Sole leather carrying cases can be furnished with 1, 2, 3 and 4 instrument compartments.



The Style D Movement used in Jewell Master A.C. Voltmeters and Ammeters.